AD A137403

(12)

NPRDC TR 84-15

JANUARY 1984

ENLISTED PERSONNEL INDIVIDUALIZED CAREER SYSTEM (EPICS) DESIGN, DEVELOPMENT, AND IMPLEMENTATION

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

DTIC
ELECTE
JAN 30 1984
B

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
SAN DIEGO, CALIFORNIA

NAVY PERSONNEL RESEARCH
AND
DEVELOPMENT CENTER
San Diego, California 92152

DTIC FILE COPY

2004 0326 035

84 01 30

NPRDC TR 84-15 January 1984

ENLISTED PERSONNEL INDIVIDUALIZED CAREER SYSTEM (EPICS) DESIGN, DEVELOPMENT, AND IMPLEMENTATION

Robert E. Blanchard
Robert J. Smillie
Harry B. Conner

Reviewed by
James W. Tweeddale
Technical Director

Released by
J. W. Renard
Captain, U.S. Navy
Commanding Officer

Navy Personnel Research and Development Center
San Diego, California 92152

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NPRDC TR 84-15	2. GOVT ACCESSION NO. AD-A137403	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ENLISTED PERSONNEL INDIVIDUALIZED CAREER SYSTEM (EPICS) DESIGN, DEVELOPMENT, AND IMPLEMENTATION		5. TYPE OF REPORT & PERIOD COVERED Final Report 1978-1983
		6. PERFORMING ORG. REPORT NUMBER 71-84-1
7. AUTHOR(s) Robert E. Blanchard Robert J. Smillie Harry B. Conner		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Navy Personnel Research and Development Center San Diego, California 92152		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63720N; Z0828-PN
11. CONTROLLING OFFICE NAME AND ADDRESS Navy Personnel Research and Development Center San Diego, California 92152		12. REPORT DATE January 1984
		13. NUMBER OF PAGES 54
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Preliminary results of EPICS test and evaluation in the fleet are provided in a companion report (NPRDC TR 84-16).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Job performance aids (JPAs)	Shipboard training
Personnel systems	Job design
Deferred training	Performance measurement
Distributed training	Career systems
Exportable training	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the design, development, and implementation of an alternative personnel system concept called the enlisted personnel individualized career system (EPICS). An integrated personnel systems approach (IPSA), based on joint consideration of training, aiding, job design, career structure, and personnel resources, coupled with a cost trade-off model, was used to evolve EPICS. R&D was conducted to extend and refine the technology base dealing with integrated personnel systems and job performance aiding and to develop a JPA-based integrated personnel system model.

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

JOB PERFORMANCE AIDS

EPICS features use of JPAs, deferred formal training, and an individualized career advancement structure. With deferred training, an individual is first sent to sea for a shipboard orientation period of from 8 to 12 months and then is returned to shore-based technical training depending upon his degree of adaptation to shipboard life and demonstrated level of interest and motivation. During this indoctrination period, the recruit receives transition training to shipboard life and is made an effective member of the ship's crew through use of JPAs. Formal training experiences ashore are distributed throughout an individual's 6-year enlistment rather than being provided prior to the first shipboard duty assignment.

Project objectives include reduced costs of first-enlistment training, shortened training pipelines, reduced skill-knowledge deterioration, and improved use of available personnel.

Currently, EPICS is undergoing test and evaluation in the fleet using the NATO SEASPARROW Missile System (NSSMS). Data are being collected to evaluate the personnel performance and cost effectiveness aspects of the EPICS model. Data collection will be completed by November 1985 with data analyses complete by March 1986. Cost benefit analysis and final recommendations will be forthcoming by September 1986.

FOREWORD

This effort was conducted under advanced development task area Z0828-PN (Enlisted Personnel Individualized Career System (EPICS)) and was sponsored by the Deputy Chief of Naval Operations (OP-01). The EPICS program, which was developed using an integrated personnel systems approach (IPSA), delays formal school training until after personnel have received shipboard on-job training complemented by job performance aids (JPAs). Early phases of the program, which involved developing the IPSA EPICs model, extending and refining JPA technology, formalizing techniques for exporting and administering training on board ship, and developing R&D implementation techniques, have been described in a series of Center reports (TRs 77-33, 78-26, and 79-25; SRs 83-32 and 83-39; TNs 79-1 and 80-14). This report provides a detailed description of the conception and development of the EPICS IPSA model, the execution of the front-end job design analyses, JPA and instructional module development, and EPICS implementation. The ongoing, longitudinal test and evaluation (T&E) of EPICS in the fleet as an experimental personnel system concept is described in NPRDC TR 84-16, which was developed as a companion to this report.

The EPICS program constitutes one of the more ambitious R&D endeavors undertaken by the Navy MP&T community. It involves the conception of an innovative personnel system, the development of supporting technology for that system, and an empirical T&E in the fleet environment over a 4-year period. The EPICS staff was repeatedly challenged with design and implementation problems that had to be addressed and resolved on a routine basis. Numerous individuals in the military and civilian offices of the Navy aided the program through their enthusiasm and support of EPICS objectives. Unfortunately, all who aided the program cannot be acknowledged here. Special recognition is due PNCM Tracy Hicks, Personnel Support Activity, Recruit Training Command, San Diego, for his wise counsel on certain design questions and continuous support during selection of EPICS subjects for the program, and FTMC Dan Leary, then in NMPC-406, for his insight and unfailing assistance in identifying and managing EPICS shipboard billets and generally facilitating the complete shipboard manning phase of the program.

Also, appreciation is extended to personnel of the NATO SEASPARROW Program Office (NSPO), NAVSEASYSCOM (Code 06P), particularly to CAPT Oscar Sanden, who was program manager at the time approval was obtained for NSSMS to be used as the test vehicle for EPICS' field test, and to CAPT Paul Bledsoe and CAPT Charles Johnson, who subsequently served as program managers and continued to be interested and active supporters of the EPICS program. Recognition is also due to Mr. Merle Malehorn, since retired from government service, who was the original OPNAV sponsor of EPICS and who was responsible for its initiation and continued funding, and to Mr. Robert Bowles, Naval Ships Weapons System Engineering Station (NSWSES), Port Hueneme, California, who was instrumental in providing engineering data for JPA development and who assisted directly in JPA validation and verification.

People-related research and development concerned with shipboard systems is greatly dependent upon the support of dedicated military professionals to lend credibility to the undertaking and to ensure that a proper balance is attained between R&D creativity and the realities of the shipboard Navy. Equally important are individuals, both military and civilian, who are willing to try something a bit different and to assume a nominal risk in doing so. The EPICS program has been highly favored in both these areas by the calibre of individuals encountered and support received.

J. W. RENARD
Captain, U.S. Navy
Commanding Officer

JAMES W. TWEEDDALE
Technical Director

SUMMARY

Problem and Background

The Navy continues to face such problems as increasing training costs, ever-tightening budgets, and a shrinking enlistable population, along with the need to man complex systems with highly technically qualified personnel. Specific concerns include long and congested training pipelines, skill/knowledge deterioration, uneven shipboard assimilation of new people, lack of effective shipboard skills training, and less than fully effective use of available personnel capabilities. In response to these concerns, R&D was conducted to extend and refine the technology base dealing with integrated personnel systems and job performance aiding, to develop a JPA-based integrated personnel system model, and to implement the model in a fleet setting and conduct a longitudinal test and evaluation program.

The resulting enlisted personnel individualized career system (EPICS) model was intended to provide an alternative to the present personnel system, characterized by front-end-loaded-training (FELT), and meet the following objectives: (1) reduce investment in shore-based training for first-term enlistees while maintaining on-job effectiveness, (2) improve coincidence of career path structure with shipboard systems organization, (3) expand the manpower pool for technical ratings through use of "non-school eligible" personnel, (4) improve the use of motivated, capable personnel early in their Navy careers, and (5) facilitate personnel shipboard adaptation.

Objective

The objective of this report was to describe the design, development, and implementation of EPICS. A companion report provides interim results of EPICS test and evaluation in the fleet.

EPICS Description

An integrated personnel systems approach (IPSA) was employed to develop EPICS. Salient features are use of job performance aids (JPAs), self-teaching exportable packages (STEPS) for shipboard training, integrated shore-based training episodes, and the notion of deferred formal technical training and early at-sea experience with an individualized career advancement structure.

In deferred training, the recruit is first sent to sea for a shipboard orientation period of from 8 to 12 months and then returned to shore for formal technical training, depending upon his degree of adaptation to shipboard life and his demonstrated level of interest and motivation. During this indoctrination period, the recruit receives transition-to-shipboard-life training and uses JPAs in order to contribute effectively to equipment operation and maintenance. Formal training episodes ashore are provided at approximately the 12 and 24 month career points in correlation with specific job requirements rather than providing all formal training prior to shipboard assignment as is typically done with FELT.

The NATO SEASPARROW Surface Missile System (NSSMS) was selected as the EPICS test vehicle. A task analysis was performed to develop job task requirement data to support job design, JPA development, specification of training objectives, and performance criteria. The "enabling behaviors" concept was employed to identify specific skills, knowledges and experiences that provided the necessary preparation to "enable" the

EPICS technician to advance to the next skill level. These "enablers" were integral to the concept of competency building blocks composed of (1) practical job experience, (2) hands-on training, (3) job performance aiding, (4) shipboard instruction (STEPS), and (5) formal shore-based (schoolhouse) training. These competency-building methods were integrated with the aim of obtaining near optimal performance from the EPICS technician at a particular career point with minimum resource expenditure.

The instructional systems development (ISD) procedures and individualized, self-paced, multimedia instructional methods were employed in the EPICS training program, along with closely integrated shorebased and shipboard training episodes. That instructional approach was intended to combine with practical job experience and use of JPAs to produce the competencies required for a given skill level.

Existing JPA technology was applied for non-troubleshooting tasks for lesser-experienced technicians and new JPA techniques were developed for aiding troubleshooting tasks performed by experienced technicians. JPA technology advancements included the "hybrid" JPA, which includes two levels of technical data embedded within the same format and the "enriched" JPA, which features explanatory information attached to a particular task or step to facilitate the learning process. These two innovations promise to reduce the overall costs of producing JPAs while improving their effectiveness as a means for enhancing personnel performance.

Status and Plans

Currently, EPICS is being subjected to a longitudinal test using the NSSMS and the fire control (surface missile) (FTM) rating as the test vehicle. Enrolled during recruit training, 146 EPICS personnel were assigned to 30 DD 963 class ships and to 4 CVs in the Pacific and Atlantic Fleets. FTM and general detail cohort groups are being tracked along with the EPICS sailors throughout their enlistments. The primary objective is to compare measures of job performance and relative costs for EPICS and traditionally-trained FTMs so that unequivocal judgments can be with respect to EPICS as an alternative career system.

It is anticipated that fleet data collection will be completed by November 1985 with all data analyses in hand by March 1986. Cost effectiveness and cost benefits analyses for various personnel use strategies will be completed by September 1986.

CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

INTRODUCTION

Problem

Steadily increasing technological complexity of military hardware systems over the past 25 years has continually challenged the services to supply needed personnel resources that can meet operational and maintenance requirements at an affordable cost. At present, personnel account for over 60 percent of total life cycle costs (U.S. Commission on Defense Manpower, 1976).

Selection, assignment, and training are the approaches typically used for producing the qualitative levels of personnel required. Currently, formal (schoolhouse) training is still the approach most relied upon, at a current cost exceeding $30,000 per system technician (Megrditchian, 1983). These investments are usually "front-end-loaded" in that all training is provided prior to initial job assignment and before the incumbent achieves job (shipboard) adaptation and experience. Where relatively high turnover conditions exist (attrition during enlistment or failure to reenlist), a just return for such substantial training investments is seldom realized.

Other factors that exacerbate the problem concern time and expense of the long pipelines to the operational unit and skill and knowledge deterioration during periods of nonuse. With high-technology systems, it is not unusual for the initial training pipeline to exceed 60 to 70 weeks. When leave and holidays are considered, a budding technician could be in the training pipeline for 14 months or more before he arrives at his first duty station. During this time, of course, and during the period of assimilation into the work unit, his recently acquired skills and knowledge are deteriorating.

Formal technical training is an important and vital means for developing the skills needed for the more advanced technical jobs, particularly for the career force. However, available evidence argues that heavy "front-end-loaded" training is not the most cost-effective route to follow in preparing recruits for their first technical jobs in the fleet. More information is needed on an individual's adaptability and his potential as a career force member before such commitments are made.

A concept proposed here is that first enlistment training investments should be deferred and distributed. The need is to defer large investments in training until the uncertainty concerning expected payoffs (continued availability of recipient) can be reduced. Further, training that is provided needs to be more contiguous with actual job requirements; that is, job requirements need to be clustered by skill levels within the first enlistment and training distributed accordingly among those levels. Training for a higher level would not be provided until the individual has demonstrated competence (and his continued presence) at the previous level.

Job performance aiding is an ideal means for making the recruit an effective team member without requiring formal training in order to buy time to test his worthiness and adaptability. It is noted that, for practical purposes, aiding is considered the complement of training; that is, a rather direct trade can be made ("head-book trade-off") from training to aiding during perhaps the first 18 to 24 months of an individual's career.

Background

There is little doubt that job performance aiding technology can be a powerful adjunct to training (and selection) when considered in an integrated fashion. A rather

large number of studies have been conducted over the past 20 years demonstrating potential benefits from the use of job performance aids (JPAs) (see Rowan, 1973; Shriver & Hart, 1975; Booher, 1977, 1978; and Foley, 1978). The types of gains realized related to (1) training time, costs, and resources, (2) cross-training time, (3) fault isolation time and mean-time-to-repair, (4) cost savings in number of spare parts used, (5) savings in number of nonfailed parts discarded, (6) increased supervisor span-of-control, (7) lesser-skilled technicians performing higher-skilled tasks, and (8) benefits from use of lesser-aptitude personnel.

Although the above studies pointed out potential gains to be realized from use of JPAs, they also demonstrated that serious implementation problems can occur, such as supervisory rejection of personnel using JPAs, arbitrary job assignment limitations, and failure of aided personnel to pass knowledge-based tests for advancement even though they were doing the job satisfactorily. Klesch (1977) pointed out the dangers of introducing JPAs into an existing job without due regard for interaction with job design, career path structure, formal training and organizational structure. The lesson to be gained here is that job performance aiding technology is feasible only if an integrated personnel systems approach (IPSA) is employed (see Blanchard, 1979). Too often, people tend to perceive a problem as a training or retention problem when it is a personnel system problem. The single element approach not only precludes achieving anywhere near optimum use of resources, but also thoroughly understanding the nature of the real problem.

To motivate the services to explore the potential applications of JPA technology, a tri-service committee was established in 1977 under the guidance of the Office of the Assistant Secretary of Defense (OASD) (MRA&L). This committee produced a report exploring two concepts: (1) The need to implement the existing technology base in job performance aiding and (2) the need for increased effort on integrated technical data, training, and personnel support systems (see Foley, 1978).

In response to these concerns, an integrated personnel systems approach (IPSA) (see Figure 1) was employed to develop the enlisted personnel individualized career system (EPICS), which attempts to reduce training costs by deferring expensive shore-based training (Blanchard & Smillie, 1980). It provides apprentice personnel with on-the-job experience, complemented with job performance aids (JPAs) and self-paced instructional materials. After these personnel have completed apprentice technician duty (ATD) and demonstrated satisfactory job performance to their supervisors, they are sent to shore-based equipment technician training (ETT) and, eventually, to system technician training (STT) during their enlistment. Thus, the EPICS program integrates technical progress, shipboard adjustment, and educational opportunities into an individualized career path. Specific objectives were to:

1. Reduce the investment in shore-based training for first-term enlistees while maintaining on-job effectiveness in the fleet.

2. Improve span and definition of career path structure and the coincidence of that structure with shipboard system organization.

3. Expand the manpower pool for technical ratings through use of "lesser-aptitude" personnel; that is, those considered "non-school eligible" according to Armed Services Vocational Aptitude Battery (ASVAB) test scores.

4. Facilitate the identification, development, and utilization of motivated, capable personnel early in their Navy careers.

5. Facilitate personnel adaptation to military and shipboard social and physical environments.

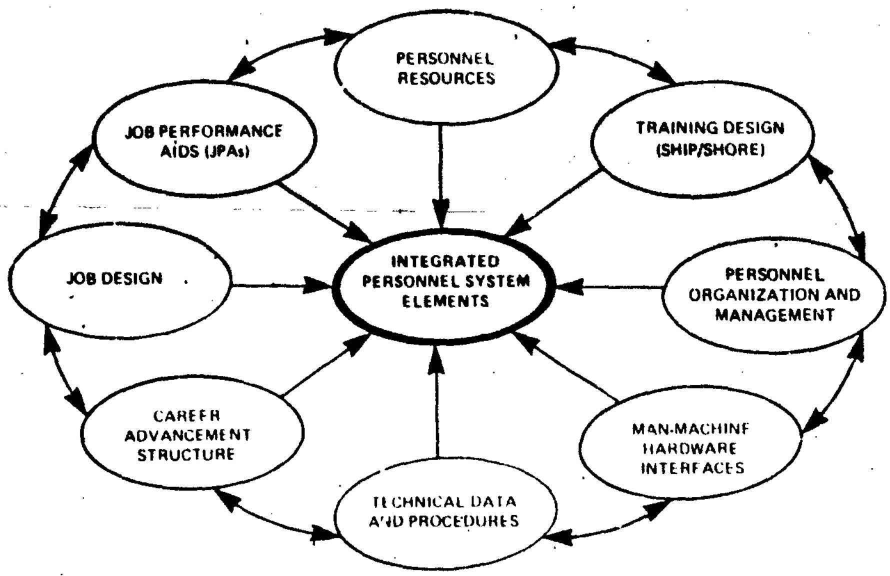


Figure 1. Overall IPSA concept.

Enrollment of EPICS personnel commenced in July 1980 during routine classification interviews conducted at the Recruit Training Command (RTC), San Diego. EPICS candidates were selected from the general detail (GENDET) recruits; that is, those who had not entered the Navy with school guarantees. The prospective EPICS recruit was briefed on the program, shown the materials, and offered a billet on a specific ship. If possible, his preference for the Atlantic or Pacific coast was considered. The Navy classifiers (Personnelmen--N=4) who recruited EPICS personnel received no special training other than review of the program, the recruiting pamphlet, and the EPICS sailor's handbook.

A total of 158 EPICS candidates was enrolled to fill billets on 34 ships (four billets on each of 30 DD 963-class ships and five billets on each of 4 CV-class ships) in the Pacific and Atlantic fleets. The NATO SEASPARROW Surface Missile System (NSSMS), which is operated and maintained by personnel in the fire control technician (surface missile) (FTM) rating, was selected as the test system. Candidates were assigned to two groups, depending on whether or not they were eligible to attend Fire Control Technician (FT) "A" school, based on scores obtained on the ASVAB.[1]

[1]To be eligible for FT "A" school, recruits must have a composite score of 218 on ASVAB subtests related to skills in that school (EI+MK+GS+AR). It should be noted, however, that recruits scoring below 218 are eligible for other "A" schools.

The FT-ineligible group was included in the EPICS program to determine whether a lesser aptitude group, as defined by ASVAB composite scores, would add effectively to the Navy's technician manpower pool. This question was considered worthy of study because of the shrinking enlistable population and because ASVAB scores rely heavily on verbal comprehension and test-taking ability factors, which are only marginally related to on-job performance. Of interest here was the on-job contribution of the FT-ineligible group when placed in a "hands-on" situation in the fleet and supported by JPAs, their ability to progress on shipboard using self-teaching exportable modules (STEPS), and, most particularly, their performance in formal technical training courses ashore where ASVAB scores traditionally are predictive of performance. If the performance of the FT-ineligible group does not differ significantly from that of the FT-eligible group and personnel in the FTM rating, this subgroup can be used to increase the available number of potential FTM trainees, resulting in a net favorable consequence to the Navy.

Table 1 gives EPICS manning levels in each group for Atlantic and Pacific fleets of the 146 candidates remaining after recruit training. The average armed forces qualification test (AFQT) scores given provide an additional descriptive measure of the two groups.

Table 1

EPICS Manning Levels for Atlantic/Pacific Fleets

Group	Fleet Assignment			Average
	Total	Pacific	Atlantic	AFQT Score
FT-eligible	75	42	33	77.1
FT-ineligible	71	33	38	54.2
Total	146	75	71	

Purpose

This report provides a detailed description of the conception and development of the EPICS IPSA model, the execution of front-end job design analyses, JPA and instructional module development, and EPICS implementation. The preliminary results of the EPICS test and evaluation (T&E) in the fleet are described in a companion report (Blanchard, Clelland, & Megrditchian, 1984).

EPICS MODEL DESIGN AND DEVELOPMENT

Design Guidelines

During EPICS conceptualization, the following design guidelines were evolved to ensure responsiveness to the previously-stated objectives:

1. Place recruits in a shipboard apprentice program directly from recruit training and provide for ship and job indoctrination. Require EPICS personnel to work as mess cooks, clean compartments, and perform other facilities maintenance as a scheduled part of the program.

2. Defer and distribute shore-based technical training over a 4-year enlistment and provide such training in two episodes: equipment technician training (ETT) at the 12th month and system technician training (STT) at the 24th month.

3. Conduct job design studies and define three skill levels for the first 4-year enlistment: apprentice technician, equipment technician, and system technician (skill levels I, II, and III).

4. Develop fully proceduralized JPAs (FPJPAs) for use in meeting all technical job requirements during skill level I; partially proceduralized JPAs (PPJPAs), during skill level II; and advanced troubleshooting aids (e.g. state tables), during skill level III.

5. Invest in individual shore-based training as a function of demonstrated interest, performance, level of shipboard adaptation, completion of all program and military prerequisites, and recommendation of the ship's commanding officer (CO).

6. Provide shipboard instruction by means of self-teaching exportable packages (STEPs) with narrative, summary, and programmed instruction, including subject-scored module tests and supervisor-scored comprehensive tests.

7. Develop technical competency through building blocks involving practical job experience (PJE), job performance aiding, on-job training (OJT), instructional modules provided for each skill level (STEPs), and shore-based, resident school training (RST).

8. Provide a personnel career system with supporting organization, explicit advancement paths, integrated training episodes and JPAs, specified time frames and prerequisites, assessment points, promotion points, and career decision points. Also, consider such factors as new personnel assimilation into fleet units, demotivation, turbulence, and attrition contributors.

Development of Implementation Model

The original IPSA concept (Blanchard, 1979; Blanchard & Laabs, 1978; Blanchard & Smillie, 1980) was used as the general model for developing and implementing the EPICS model subjected to T&E. However, certain features of the general model could not be included due to practical considerations: (1) the recruitment function was not included since subjects had to be enrolled during recruit training, (2) the notion of a "cluster option" in which EPICS recruits were assigned to a shipboard department was not included because the T&E required that they be assigned to a division, and (3) a "job enlargement" path that provided for increasing the number of tasks included in a particular job without increasing skill/knowledge requirements was not included because it was not a practical or necessary feature.

As was described previously (Blanchard & Smillie, 1980), the first step in model development was representation of the primary functions of a personnel system: screening/placement, career planning and progression, shipboard training, shore-based training, skill development, performance evaluation, assignment/reassignment, position (job) definition, compensation (incentives/rewards), scheduling, system monitoring, and administration. As shown in Figure 1, development efforts considered the interactions between training, aiding, technical data, career enhancement, resource use/cost, and job performance requirements. Apprentice technician (skill level I) performance was supported by FPJPAs; equipment technician (skill level II) performance, by PPJPAs; and system technician (skill level III) performance, by standard OPs and MRCs, with JPAs used only for infrequently performed tasks. This design utilized the "head-book" tradeoff progression inherent in JPA-based personnel systems.

The skill hierarchy proposed by the original general EPICS model included four skill levels (the three indicated previously, plus level IV for master technician), with three subdivisions within each skill level to provide for advancement opportunities. However, for EPICS implementation, this hierarchy was reviewed to include the three levels previously discussed, plus two others to provide for higher skill levels. The subdivisions within skill levels were revised to better accommodate the existing pay grade structures. Thus, the revised skill hierarchy was as follows:

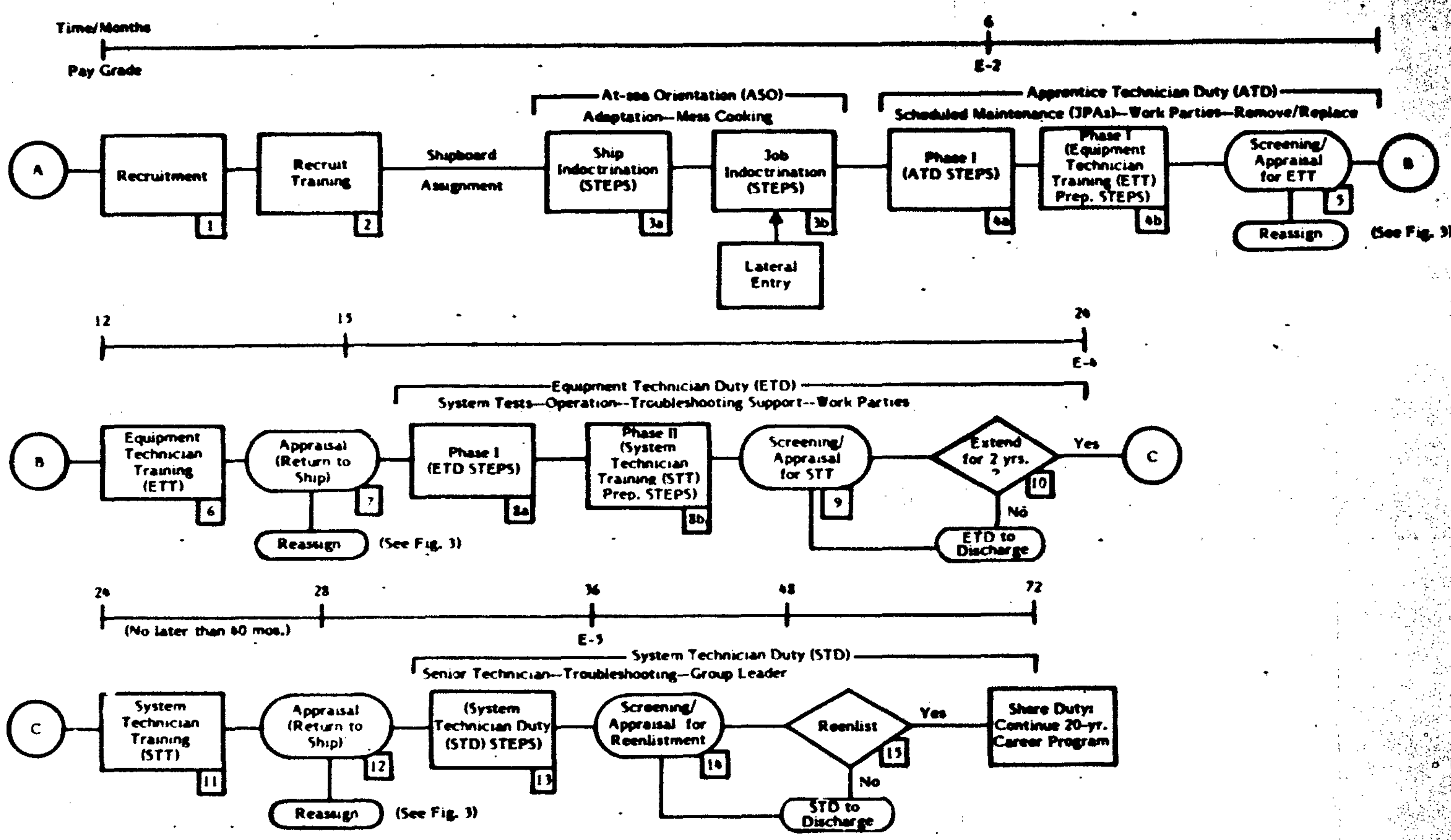
Skill Level	Title	Pay Grade
I	Apprentice technician	E-1, E-2
II	Equipment technician	E-3, E-4
III	System technician	E-4, E-5
IV	Improved point defense system technician	E-6, E-7
V	Combat weapons system technician	E-8, E-9

A logic-flow approach was used that allowed the various functions to be organized into a graphic model depicting the JPA-based IPSA and placed on a temporal continuum. This graphic depiction was used as a working tool in reviewing the various provisions with subject matter experts (SMEs) representing the personnel, manpower, training and operational communities that contributed to model development.

EPICS Career System

Figure 2 illustrates the EPICS career system for a 6-year program; that is, for personnel who enlist for 6 years for a "guarantee" or who enlist for 4 years and then extend or reenlist for the required term. For the T&E, the entire 6-year program had to be completed in 4 years since only 4-year obligors were available as subjects for the study; that is, after EPICS personnel had completed STT, they had only 12 months of service remaining rather than the 24 months minimum that would be required for the standard 6-year program.

The event timelines shown in Figure 2 are for general guidance only. The flexibility inherent in EPICS allows a rather broad range of actions by individual ships in response to individual performance of EPICS technicians and ship operating schedules. For example, eligibility for ETT can be and was assessed nominally around 12-14 months of service. In actual practice, some individuals were recommended for ETT as early as 6-8 months, depending upon the ship's operating schedule and the technician's progress. A primary EPICS objective is to provide for acceleration of individuals who are highly motivated and eager to advance.



Notes.

1. Events coded to description in text.
2. STEPS = Self-teaching exportable packages (Instructional modules)

Figure 2. EPICS 6-year career system model.

This flexibility is most critical during the equipment technician duty (ETD) period (15-24 months). In the 6-year model, the 4-year obligor must decide whether to extend or reenlist no later than the 44th month in order to meet the requirement for 24 months available to EAOS following STT. However, a particularly promising individual could decide to extend/reenlist (with his CO's recommendation) as soon as he completes ETT-preparation (ETT-P) training modules. Hence, if he decides to extend/reenlist at the 24th or even the 30th month, as suggested, he will gain additional time in which he can do the required training and be assignable as a coded technician.

Appraisal/Assignment Process

The appraisal and decision-making process is continuous through the EPICS program. However, as can be noted in Figure 2, there are a number of appraisal points that are time/event-related and are specifically identified. In the interest of clarity, Figure 3 is provided, which shows that the EPICS model includes five appraisal/decision/assignment paths:

1. Track 1, the primary NEC track (1148 for T&E study) in which personnel proceed along designated EPICS career path.

2. Track 2, the non-NEC track, in which it is determined that the individual is not capable of progressing in the EPICS career path, but remains within EPICS in the work center as an NEC 0000.

3. Track 3, in which it is determined that the individual will not continue within the EPICS career path and is assigned to the general work force (deck).

4. Track 4, in which the individual is laterally assigned to another rating track.

5. Track 5, in which the individual is discharged from the Navy.

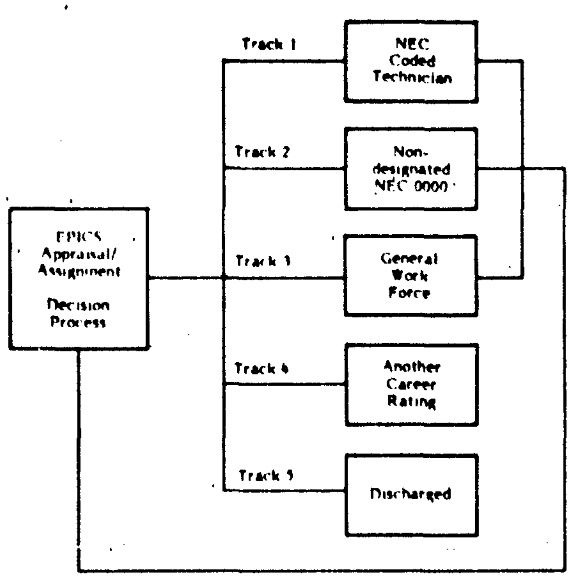


Figure 3. EPICS career paths resulting from the appraisal and assignment process.

Although losses to the Navy occur only with Track 5, transfers to Tracks 2, 3, and 4 represent losses of potentially system coded technicians in the primary rating pipeline (FTM). Track 2 individuals are those who are considered effective workers in the work center but, for whatever reason, have difficulty completing the necessary shipboard/shore-based training requirements necessary for an NEC or simply choose not to extend or reenlist (assuming CO recommendation). Ideally, losses to the primary rating pipeline through Tracks 3, 4, and 5 will occur prior to ETT, when the investment of an individual is relatively low. Some Track 2 assignments conceivably could occur prior to ETT; however, from a practical standpoint, most ships will likely need at least 12-14 months to feel confident in retaining an individual in the non-NEC track. Experience has shown that persons transferred to another rating (Track 4) constitute an extremely small proportion of losses to the primary rating pipeline and will occur relatively infrequently during the first 6-12 months of service. It is hoped, of course, that losses after ETT will be minimal, with all being accounted for by Track 2 transfers.

It is noted that EPICS is intended to provide for periodic screening and assessment so that an individual is advanced or reassigned to a career track most consistent with his aspirations and capabilities. For example, an individual screened for Track 2 ideally would have the opportunity, assuming he met all prerequisites, to be considered for reentry into Track 1. Of course, Track 3 individuals have the opportunity to enter Track 1 as NEC candidates on a lateral entry basis from the general workforce. It is possible for an individual who has been assigned to Track 3 (general work force) from Track 1 (coded technician) to be reassigned back to Tracks 1 or 2 (particularly Track 2); however, in most cases, he would have to demonstrate exceptional dedication and performance.

EPICS DEVELOPMENT

Task Analyses

As indicated previously, NSSMS was selected to serve as the vehicle for EPICS' fleet T&E. There were several reasons for this:

1. It was relatively new and, hence, would be retained in the fleet for some time.

2. It involved solid-state digital electronics, was installed on four different ship classes in adequate numbers (CV, DD 963, AOE, and AOR), and had excellent configuration management.

3. Finally, and perhaps most importantly, the NAVSEA program manager for NSSMS was agreeable to the proposition.

As a prerequisite to the development of EPICS, a task analysis (front-end analysis) was performed to develop job task requirement data to support job design, JPA development, training objective specification, and performance assessment. SMEs, system procedural manuals, and actual system equipment were used to generate and validate specific task requirements data. These data were then used to extend and verify existing task analysis data and to identify the behavioral requirements of the EPICS' technician's job at the three skill levels desired.

The "enabling behaviors" concept was employed to identify those skills, knowledges, and abilities that provided the necessary preparation to "enable" the NSSMS technician to advance to the next skill level. These enabling experiences were integral to the concept

of competency building blocks composed of (1) practical job experience, (2) on-the-job training, (3) job performance aiding, (4) STEPS for shipboard instruction, and (5) formal shore-based (schoolhouse) training. An attempt was made to integrate these competency-building blocks in a manner that would result in optimal job performance capability of the EPICS technician at a given point in time with minimum resource expenditure. Enabling experiences were identified and tracked to ensure that each skill level contained those tasks and learning experiences necessary to prepare (enable) the EPICS technician to advance to the next skill level.

Instructional Program

Development

The EPICS model incorporated the techniques of the instructional systems development (ISD) process and individualized, self-paced, multimedia instructional methodologies. Critical to the training approach employed was the integration of shore-based training, shipboard training, and performance aiding directed toward meeting specific job performance requirements. Also, the acceleration and remediation concepts were important considerations in model development. Figure 4 illustrates the EPICS instructional system model that was used with all instructional materials (STEPS), except for the STT, which is a conventional lecture course with a laboratory section. Learning materials were presented in three instructional formats: summary, narrative, and programmed instruction (PI).

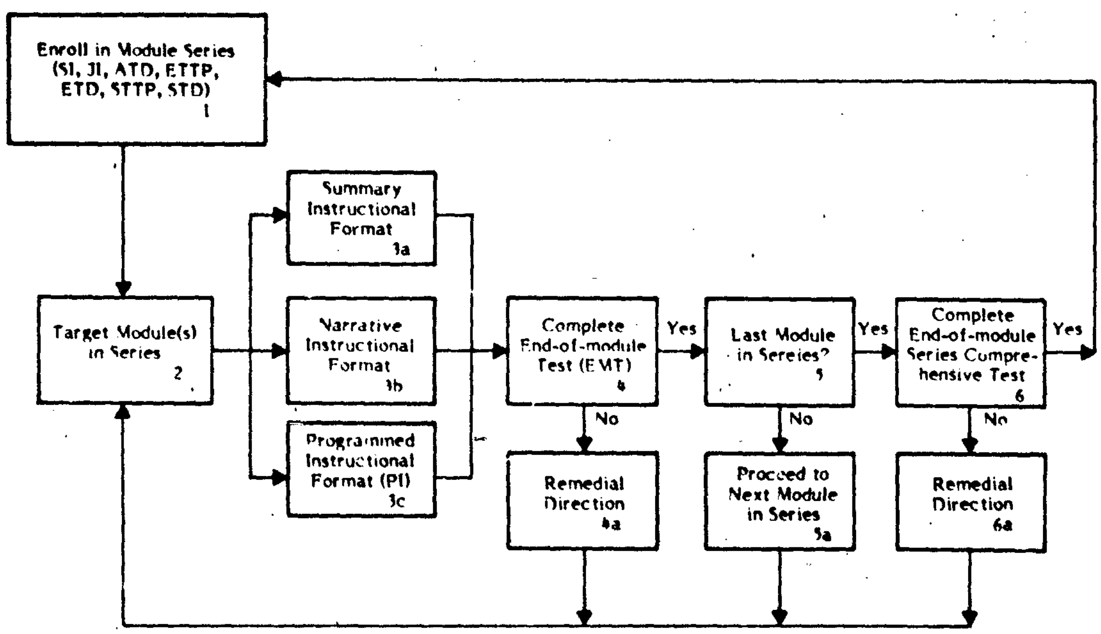


Figure 4. EPICS instructional system model.

As can be seen, after the trainee is enrolled in a module series appropriate for his career point in the program (Block 1), he selects the target module (Block 2) and the form of instructional presentation most consistent with his particular experience and/or learning ability (Block 3). This approach allows him to "accelerate" through the program at a pace consistent with his individual motivational level and learning capacity.

Once a trainee completes a module, he takes an end-of-module (EOM) test (Block 4) to ensure that he has mastered the learning objectives in that module. If he does not complete the EOM test satisfactorily, he is provided remedial instruction (Block 4a); that is, he restudies those lessons in the module where he was found to be deficient. He would then be reassessed by taking a parallel form of the EOM test. If successful, he either proceeds to the next module in the series (Block 5a) or, if he has completed the last module (Block 5), takes a comprehensive test over all the modules in that series (Block 6). Here again, if the comprehensive test is not completed satisfactorily, he is provided remedial instruction in those module(s) and lesson(s) he needs to restudy (Block 6a). He can continue to be remediated in this fashion as long as the EPICS administrator wishes; however, usually no more than three iterations are needed or allowed.

The EPICS instructional program is based on closely integrated shore-based and shipboard training episodes. Such instruction, as indicated earlier, was intended to combine with practical job experience (PJE) and use of JPAs to develop the competency levels required at a particular skill level. As with the other components of EPICS, the instructional program was based on task and behavioral analysis data. Particular attention was paid to identifying specific job performance requirements and associated learning objectives as a prerequisite for establishing a training requirement. Such an approach is vital to protect against the incorporation of training content that is based on "folk lore" rather than on objectively defined needs. Descriptions of EPICS' shipboard and shore-based training courses follow.

<u>Shipboard Instructional Program</u>

Shipboard-exported instructional materials needed to be multi-purpose; that is, they had to be portable so they could be used in the shipboard environment and individualized/self-paced for individuals who entered the program at differing times with differing experiences and learning aptitudes. They had to be easily administered and absolutely relevant if the program was to receive the support of shipboard personnel.

There are eight sets of shipboard instructional modules, which are described in Table 2. They were constructed in three formats, as shown in Figure 4:

1. <u>Summary</u>. Intended for those personnel who had previous experience in the subject matter being covered and/or high learning aptitude (approximately 23% of the population) or for review of a lesson in preparation for taking an end-of-module (EOM) or comprehensive test.

2. <u>Narrative</u>. Intended for the "average" student, one who was used to learning from a textbook format with a mix of experience and learning ability (approximately 54% of the population).

3. <u>Programmed Instruction (PI)</u>. Intended for those persons who were inexperienced or had limited learning ability (approximately 23% of the population) and who needed information presented in small steps with a high level of response demand and feedback. PI could also be used by the entire population for remediation and/or an in-depth treatment of a difficult-to-understand topic.

Table 2

Shipboard Instructional Program

Module Set	Module Topics	Description
Ship indoctrination (SI)	1. Ship locations, schedules, and procedures. 2. Common shipboard hazards and safety precautions. 3. Introduction to life aboard ship. 4. Common requirements of maintenance personnel. 5. U.S. Navy regulations, personnel improvement, and preliminary introduction to tools.	Provide "survival" information to aid new personnel entering shipboard life to adapt to the shipboard environment; to be completed during the first week aboard ship.
Job indoctrination (JI)	1. General safety procedures. 2. General and special tools. 3. Shipboard maintenance and record keeping. 4. NATO SEASPARROW Surface Missile System (NSSMS).	Intended to introduce EPICS personnel to their department/division and to provide survival information as they enter that department/division.
Apprentice technician duty (ATD)	1. Maintenance aids and documents. 2. NSSMS functional review: Part 1. 3. NSSMS functional review: Part 2. 4. NSSMS operator training: Part 1. 5. NSSMS operator training: Part 2. 6. Test equipment operation.	Intended to introduce personnel to the work center and to NSSMS, including theory of operation and operator training; provide information necessary to perform the first level of job performance aids (JPAs) developed for EPICS.
Equipment technician training-Preparatory (ETT-P) (Basic electricity)	1. Basic voltage and current measurements in a simple circuit. 2. Relationship of voltage current and resistance. 3. Use of the Simpson 260-5P multimeter. 4. Variational analyses of DC-series circuits. 5. Parallel circuits. 6. Combination DC circuits. 7. Special DC circuits. 8. Introduction to AC test equipment. 9. Introduction to inductors. 10. Transformer identification and operation. 11. Introduction to capacitors and RC/RL time constants. 12. RL and RC filters. 13. Series resonance circuits. 14. Parallel reactive circuits.	These modules are the first 14 modules of the shore-based ETT course; intended to introduce EPICS personnel to basic electricity and electronics and prepare them for ETT.

Table 2 (Continued)

Module Set	Module Topics	Description
ETT 40-series (Digital fundamentals)	40. Number systems. 41. Basic digital logic. 42. Boolean algebra. 43. Registers and counters. 44. Displays and outputs.	Can be accomplished at ETT or on board ship; this approach supports the fixed-time, variable-content format of the ETT course. When necessary, the ETT 20- and 30-series (see Table 2) are provided to the ships to support slower learners who were unable to complete them in the time allowed for ETT.
Equipment technician duty (ETD)	1. Introduction to system troubleshooting. 2. NSSMS daily system operability test (DSOT) and firing officer's console (FOC) built-in test (BIT) off-line test procedures. 3. Radar set console (RSC) and radar target data processor (RTDP) off-line test procedures. 4. NSSMS guided missile fire control system (GMFCS) BIT off-line test procedures. 5. NSSMS guided missile launching system (GMLS) 6. Operator procedures: Part 3. 7. Operator procedures: Part 4. 8. Operator procedures: Part 5.	Support the EPICS ETC skill level (II); provide a more in-depth treatment of NSSMS from maintenance and operation points of view, as well as instruction on various NSSMS test procedures.
System technician training--Preparatory (STT-P)	1. Introduction to generators. 2. Introduction to motors. 3. Introduction to synchros and resolvers. 4. Introduction to servos and electromechanical devices. 5. Role of radar in combat weapons system. 6. Radar fundamentals. 7. Introduction to continuous wave (CW) doppler radar systems. 8. NSSMS fire control and launching systems. 9. NSSMS computer complex. 10. Introduction to the STT course.	Designed to prepare personnel for entry into shore-based STT; provide in-depth theory of NSSMS operation and information on electronics and electromechanical devices not previously covered.
System technician duty (STD)	1. Administration of 3M and personnel qualification standards (PQS). 2. Administration of training and supply. 3. Combat systems reports and documentation. 4. System interfaces and weapons doctrine. 5. NSSMS system-embedded training (SEAT).	Designed to prepare STT graduates for STD (skill level III) assignments involving the dual responsibility of senior system technician and work center supervisor.

Each lesson in a module had a progress check for self-testing. Each module had three parallel forms of an EOM test to ensure successful completion, or remediation, of each module. The students administered and checked the EOMs, while the administrator evaluated them and determined when an EOM was successfully completed. Each major set of modules (e.g., ship indoctrination) had a comprehensive test with three parallel forms that were to be administered, checked, and evaluated by the EPICS shipboard administrator. The EPICS Administration Guide (1980) provides detailed information on shipboard materials and administration procedures.

Shore-based Instructional Program

In performing Block I.4 of the ISD model (analyze existing courses), it was discovered that the computer-managed instruction (CMI) system being used at the Basic Electricity and Electronics Course (BE&E) for recruits scheduled for the FT rating met EPICS requirements for ETT except that additional modules needed to be developed to provide instruction in advanced electronics and digital fundamentals.

Evaluation of the fire control and launcher "C" school courses associated with the conventional NSSMS instructional pipeline for (FTM; GMM) indicated that two separate courses were not justified from a job requirements viewpoint and that the EPICS "system" course would prepare EPICS personnel to operate and maintain both the fire control and launcher systems of the NSSMS in an integrated manner. (It is noted that the EPICS project submitted a recommendation for integrating the FTM and GMM tracks for the conventional pipeline and that change has since been made.)

Equipment Technician Training (ETT). EPICS personnel who have completed all required shipboard requirements and are recommended by their COs are sent TDY to ETT, their first resident training episode, conducted at the Service Schools Command, Naval Training Center, San Diego, California. ETT is an individualized, self-paced course using criterion-referenced testing, multimedia presentation, and CMI. It was designed to train new personnel in basic and intermediate electricity and electronics and digital concepts necessary to perform during ETD (skill level II). The content of the course is presented in Table 3.

ETT instructors were civilian instructional specialists who were experienced in the technical material and individualized instructional methods. The course was divided into the 37 instructional blocks (modules) shown in Table 3, with mastery of the material in each block or module required before the student could move to the next module. Completion time for the modules and the course varied based on individual ability.

The course had a fixed completion time of 14 weeks. The EPICS program, however, had the necessary flexibility to accommodate both faster and slower students through a variable-content, fixed-time approach. Students who completed ETT in less than 14 weeks could return to their ships early or were allowed to accelerate in the program by taking advanced instructional modules (e.g., ETD shipboard modules). Students who did not complete the entire set of ETT modules within the allotted time were able to complete the course aboard the ship in that the last two series (30 and 40 series) were exportable. Once the slower student had in fact completed all the ETT modules, the EPICS administrator notified the EPICS Project Office and a certificate of completion was issued.

System Technician Training (STT). This shore-based course, which is provided at the Combat Systems Technical Schools Command, Mare Island, California, teaches the

Table 3

Equipment Technician Training Course Content

Indoctrinational Area	Module #	Title
Basic Electricity	ETT 1.0	Basic voltage and current measurement in a simple circuit
	ETT 2.0	Relationships of voltage, current, and resistance
	ETT 3.0	Use of Simpson 260-5P multimeter
	ETT 4.0	Variational analysis of DC series circuits
	ETT 5.0	Parallel DC circuits
	ETT 6.0	Combination DC circuits
	ETT 7.0	Special DC circuits
	ETT 8.0	Introduction to AC test equipment
	ETT 9.0	Introduction to inductors
	ETT 10.0	Transformer identification and operation
	ETT 11.0	Introduction to capacitors and RC/RL time constants
	ETT 12.0	RL and RC filters
	ETT 13.0	Series resonant circuits
	ETT 14.0	Parallel reactive circuits
Basic Troubleshooting	ETT 15.0	Soldering techniques
	ETT 16.0	Introduction to operation and maintenance manuals
	ETT 17.0	Basic oscilloscope operation
	ETT 18.0	Basic troubleshooting techniques
	ETT 19.0	Troubleshooting the amplifier stages in a radio receiver
Basic Electronics	ETT 20.0	Solid state power supplies
	ETT 20T.0	Electron-tube power supply
	ETT 21.0	Basic transistor theory
	ETT 21T.0	Multi-element vacuum tubes
	ETT 22.0	Oscillators
	ETT 23.0	Multivibrators
	ETT 24.0	Wave shaping guide
	ETT 25.0	Special devices
Intermediate Electronics	ETT 30.0	Intermediate power supplies
	ETT 31.0	RF, IF, and video amplifiers
	ETT 32.0	Intermediate oscillators
	ETT 33.0	Special devices
	ETT 34.0	Linear integrated devices
Digital Fundamentals	ETT 40.0	Number systems
	ETT 41.0	Basic digital logic
	ETT 42.0	Boolean algebra
	ETT 43.0	Registers and counters
	ETT 44.0	Displays

Note. The 30 and 40 series of modules are available aboard ship and are used for ETT completion by those EPICS personnel who did not complete all modules within the 14-week period in San Diego.

detailed theory of operation of the NSSMS and how to troubleshoot and maintain the NSSMS at the ship replaceable unit/assembly (SRU/SRA) level. To be eligible for STT, the EPICS technician must have successfully completed all previous portions of the EPICS program and be recommended by his CO. In addition, he must have at least 1 year of obligated service remaining following completion of the course.

As shown in Table 3, the STT course is 18 weeks long and is divided into seven units. The first covers the overall system; and the other six, one of the major NSSMS systems or components. Course units are divided into two or more lesson topics. For most lesson topics, instruction is given during both classroom presentations and laboratory exercises. During laboratory exercises, which are constructed around scheduled and unscheduled maintenance activities, the student is required to perform a task described on an MRC. In most instances, these exercises cover testing, alignment, and adjustment activities. After students perform the exercises, a small sample of exercises is administered as a laboratory quiz. Students receive a passing score on each exercise when they perform the task without procedural error and without violating safety procedures. The student is required to restudy and then to perform correctly any procedures first performed incorrectly.

During troubleshooting lab periods, students, working in pairs, participate in troubleshooting exercises, which can be either paper-and-pencil exercises or "hands-on" exercises. During a paper-and-pencil exercise, students are provided with a description of the symptoms relating to a malfunction. Then, using specially prepared materials, plus appropriate (OPs) and troubleshooting JPAs, the students select test points, receive information about the signals at those points, and, based on a series of measurements and interpretations, isolate the fault to a replaceable SRU/SRA.

For "hands-on" exercises, a fault is created in the system by inserting a known faulty component or by inducing an incorrect signal (e.g., by grounding a pin). The student is given a description of the problem, as identified during a DSOT. Then, using appropriate OPs, troubleshooting aids, and testing equipment, he isolates the fault to a replaceable SRU/SRA. Acceptable safety practices must be followed. An instructor observes student activities and gives a "passing" score for the exercises when the student has identified the fault, follows acceptable fault isolation procedures, and met safety practices. If students "fail" a hands-on exercise, they are required to (1) determine an acceptable procedure for isolating the fault, using OP material and troubleshooting JPAs, and (2) describe the procedure to the instructor, who scores the procedure as "acceptable" or "unacceptable."

A sample of troubleshooting "hands-on" exercises is administered as a laboratory quiz. Students take these quizzes individually and receive a passing score on a quiz item when they correctly identify the faulty SRU, using acceptable troubleshooting and safety procedures. For items failed during a quiz, the student is required to develop an acceptable procedure for troubleshooting the fault and describe this procedure to the instructor (see preceding paragraph).

For lengthy lessons, one or more classroom quizzes have been prepared. These quizzes, which are administered after a block of instruction within a lesson topic has been presented, consist of multiple-choice and matching questions. The quizzes are scored and students requested to restudy material related to those items answered incorrectly.

When a student completes a lesson topic, he takes a test covering the enabling objectives for that topic. The test consists of a sample of classroom quiz items, laboratory and fault isolation exercises covered in previous portions of the lesson, and new

Table 4

ICO Organization of EPICS System Technician Course
Sequence of Instruction

Week	Unit/Lesson Topic	Hours
	1.0 NSSMS Theory	
1	Lesson Topic 1.1 NSSMS theory of operation	28
	Lesson Topic 1.2 Digital theory	28
		56
2		
	2.0 Computer Complex	
3		
4	Lesson Topic 2.1 Computer	80
5	Lesson Topic 2.2 Signal data converter (SDC)	104
5	Lesson Topic 2.3 System evaluation and trainer (SEAT)	40
6		
7		224
	3.0 Operator Consoles	
8	Lesson Topic 3.1 Radar set console (RSC)	40
9	Lesson Topic 3.2 Firing officers console (FOC)	40
		80
10	4.0 Guided Missile Fire Control System (GMFCS)	
11		
12	Lesson Topic 4.1 Transmitter (XMTR)	64
13	Lesson Topic 4.2 Receiver (REC)	24
14	Lesson Topic 4.3 Director	32
15	Lesson Topic 4.4 Radar target data processor (RTDP)	120
		240
	5.0 Guided Missile Launching System (GMLS)	
	Lesson Topic 5.1 GMLS safety/publications	1
16	Lesson Topic 5.2 GMLS functions and physical description	1
	Lesson Topic 5.3 Initialization/troubleshooting	14
	Lesson Topic 5.4 Launcher positioning/troubleshooting	24
	Lesson Topic 5.5 Missile control unit/troubleshooting	32
		72
17		
	6.0 SEASPARROW Missile	
	Lesson Topic 6.1 SEASPARROW missile	4
	Lesson Topic 6.2 Loading/unloading	2
	Lesson Topic 6.3 Missile simulator	2
		8
	7.0 Combat Systems	
	Lesson Topic 7.1 Combat systems	4
	Lesson Topic 7.2 System casualties	36
18		40
		720

test items. The score obtained on these exams is entered into the student's course record. The student is required to restudy notes and OP material related to those exam items answered incorrectly. Students are required to develop and describe to the instructor an acceptable troubleshooting procedure for all "hands-on" laboratory and fault isolation exercise test items. Students failing to receive a 70 percent or higher score on the exam are required to restudy lesson topic material and to take a second exam covering the entire lesson.

After a student completes a course unit, he takes a comprehensive exam covering the enabling objectives for that unit and selected objectives from previous units. The comprehensive exam includes both paper-and-pencil and "hands-on" test items. Exam scores are all entered in the student's course record. Restudy and reexamination requirements are based on the same criteria as described above for end-of-lesson exams.

There is an end-of-course exam administered at course completion which is composed of a sample of paper-and-pencil test items previously encountered during quizzes and exams and troubleshooting exercises of the "hands-on" variety. The troubleshooting problems, which comprise the bulk of the exam, consist of a sample of problems encountered during the course plus a small number of problems not previously encountered. Students failing to obtain a 70 percent or higher score on this exam are required to restudy material related to failed test items and to take a second end-of-course exam. For comparison purposes, the end-of-course exam is also being administered to sailors enrolled in the conventional NSSMS course of instruction. See Table 4 for test variables related to shore-based training evaluation.

Instructional Program Test and Evaluation

Since the instructional program is an integral component of EPICS, it is addressed as part of the T&E (see Blanchard, Clelland, & Megrditchian, 1984). The shipboard instructional program will be assessed on such factors as module completion time, remediation time, ease of shipboard administration, amenability of shipboard environment for self-study, user acceptance, and effectiveness in enabling follow-on performance. The shore-based instructional program will be assessed on such factors as pre-post technical tests, completion time, remediation trials, number of setbacks, and, finally, with job-sample performance tests.

Job Performance Aids (JPAs)

Development

EPICS JPA development comprised two efforts: (1) existing JPA technology was used to develop JPAs for nontroubleshooting tasks to aid inexperienced technicians, and (2) JPAs for aiding troubleshooting tasks were defined and developed to aid the more experienced technicians. These efforts and JPA enrichment are described below.

Nontroubleshooting JPAs. To develop nontroubleshooting JPAs, it was necessary to (1) conduct a task analysis to identify and describe the nontroubleshooting maintenance tasks, (2) group these tasks according to EPICS skill levels using job design criteria, and (3) conduct a behavioral analysis to identify the enabling skills and knowledges as well as the behavioral cues and responses needed for each maintenance action.

1. Task analysis. After NSSMS was selected as the vehicle for the EPICS T&E, a task analysis was conducted in which 604 nontroubleshooting tasks were identified. Because NSSMS is a fielded system, 443 of the 604 tasks existed as maintenance procedures on MRCs. (MRCs are part of the technical information base used to support shipboard missile systems.) These 443 tasks served as a task core to which 161 new tasks were added. These new tasks were those "remove and replace" tasks, identified during the analysis, that were required to provide complete support of all NSSMS shipboard replaceable units.

Task descriptive work sheets were used to identify and describe the actions required to complete each task. The MRCs for the 443 existing tasks were used as the basis for the task actions. To ensure completeness, however, there was a hands-on validation of each MRC. All 604 tasks were supported with several photos of the NSSMS hardware and the required maintenance actions.

2. Job Design. During task analysis, the tasks were grouped into three sets according to potential safety hazards. However, job design criteria (Price, 1978; Bauman & Price, 1980) were applied to determine those tasks appropriate for a given skill level. This would ensure that the EPICS technician had a sufficient number of productive tasks to perform once he had acquired the enabling skills and knowledge.

Application of the job design criteria resulted in 84 ATD tasks. These tasks were then analyzed (Bauman & DeBor, 1980a; 1980b) to identify the cues and responses required to facilitate correct performance on each. Since one EPICS objective was to have a recruit assigned directly to a shipboard work center from recruit training and perform system-related work without any formal technical training, the JPAs developed for ATD were fully proceduralized. It was assumed that the EPICS apprentice technician would need a complete, very detailed set of maintenance procedures to perform any given task.

The results of the task analysis and the results of past JPA format studies were used to generate a specification for developing FPJPAs that used illustrations as the focal points for the task steps. Brief narrative statements were used only to support the illustration. Figure 5 is an extract from one of the FPJPAs developed for EPICS apprentice technicians. In contrast to past FPJPAs (e.g., Serendipity, 1969), both the illustrations and supporting text are fully integrated into a single frame.

For ETD, skill level II, 116 tasks were identified. Since the ETD technician will have been onboard ship approximately 1 year and will have attended ETT, it was determined that he would not need the detail contained in FPJPAs. Using the behavioral task analysis results for guidance, a specification was generated for developing PPJPAs, which focused on text rather than graphics. Locational illustrations were provided only for those ETD tasks that the technician would not have performed many times during the year he was on ATD. Figure 6 is an extract from one of the PPJPAs developed for EPICS equipment technicians. This format, although not as highly illustrated as FPJPAs, is similar in construction to the conventional FPJPA (e.g., Foley 1975); that is, the text is supported by the illustrations.

Enrichment. Enrichment is an innovative technique that was incorporated into the PPJPAs. Enrichment is information that is not required for completing a proceduralized task but is functionally related to the task and provides the user with a learning opportunity. Enrichment can range from a simple purpose statement for the task to

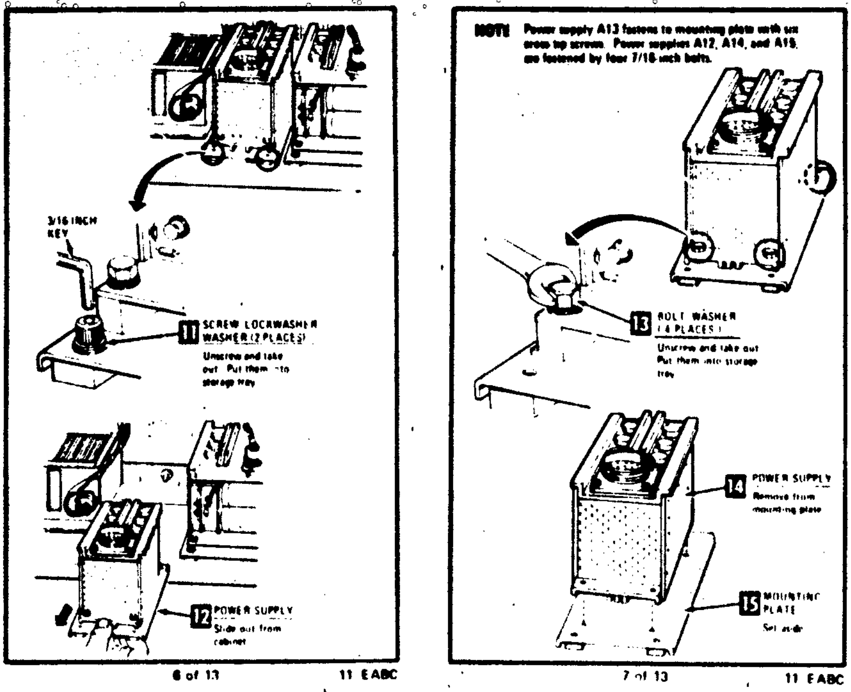


Figure 5. Extract from one of the Apprentice Duty FPJPAs.

2. Depress GENERAL CONTROLS-STANDBY pushbutton indicator; verify STANDBY indicator lights green.

3. Depress GENERAL CONTROLS-OFF pushbutton indicator; verify OFF indicator is lit.

4. At Firing Officer Console (FOC), depress SYSTEM ON/OFF pushbutton indicator; verify OFF portion of indicator is lit.

5. Set all on-board circuit breakers supplying ship's power to FOC to OFF; attach safety tags.

CIRCUIT BREAKER	LOCATION
________	________
________	________

6. Release front panel by loosening four captive screws using flat blade screwdriver, raise and lock in open position using stay bars.

7. At display module (A1) disconnect:

   a. Plug 20
   b. Plug 24
   c. Plug 22
   d. Plug 19

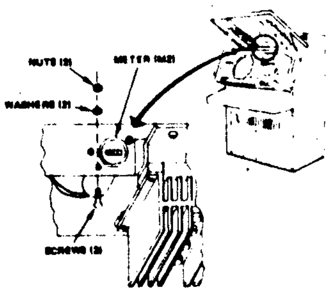
   using flat blade screwdriver.

4 of 6 12 EAHB

NOTE Ensure plugs are tucked in a safe position before sliding drawer A1 out.

8. Loosen screws securing drawer A1 using flat blade screwdriver; slide out to locked position.

9. Remove screws, nuts and washers securing meter M1 to bracket using flat blade screwdriver and 1/4" combination wrench; remove meter.



5 of 6 12 EAHB

Figure 6. Extract from one of the Equipment Technician Duty PPJPAs.

references of technical manuals that provide theoretical and descriptive information (Pulliam & Goett, 1979; Pulliam, Goett, & Smith, 1979). Figure 7 is an example of the types of enrichment that were included in the EPICS PPJPAs. Pulliam et al. demonstrated that users who are provided enrichment have a better functional understanding of an electronic system than those who are not. They also found that there were no differences in procedural errors, regardless of whether or not enrichment was incorporated into the task procedures. The addition of enrichment information, however, may increase the time to perform a given task. This increase in time is related to the amount of enrichment information.

Troubleshooting JPAs. In developing troubleshooting JPAs, unique formats were designed, developed, and tested for digital, relay, and analog-digital circuitry within the NSSMS. Digital circuitry historically has been a problem in troubleshooting because it is not enough to know whether the output (i.e., signal flow) of a circuit element is high or low, for signal sequencing information must be integrated with timing information. The state table digital troubleshooting aid (Figure 8) was developed and tested for the NSSMS missile control unit (Smillie & Porta, 1981).

Troubleshooting, in general, is a difficult skill to either train or aid. Training has to be supplemented with experience; JPAs written in a directive format do not permit technicians to comprehend functional relationships within a system. To be consistent with the objectives of EPICS, it was necessary to develop a troubleshooting JPA that provided troubleshooting information in both directive and deductive formats; that is, a "hybrid" JPA (Post & Smith, 1979). This allows the inexperienced troubleshooter to fault-isolate a problem using directive information while, at the same time, observing the fault isolation path using the deductive information. The advantage of the hybrid JPA is that, after using the directive part, the technician can easily transition to the deductive part. Also, enrichment was added to the hybrid JPAs to facilitate transitioning from the directive to the deductive format. For NSSMS, enriched hybrids were developed and tested for the relay circuitry in the launcher and the digital circuitry in the missile control units (Smith, Post, & Smillie, in press; Smillie, Smith, Post, and Sanders, in press; Smith, Post, & DeBor, 1982). Examples of these two hybrid JPAs are given in Figures 9 and 10.

A final troubleshooting JPA format, developed for a problem area in the NSSMS transmitter, was the decision tree (Smith, Post, DeBor, & Sanders, 1982). The decision tree JPA is a PPJPA developed from fault symptoms that gives an initial starting point and subsequent paths to follow based upon binary decisions (e.g., a good or bad test reading). Using the information at each decision point, the technician is guided to the casualty. Figure 10 is an extract from a decision-tree JPA.

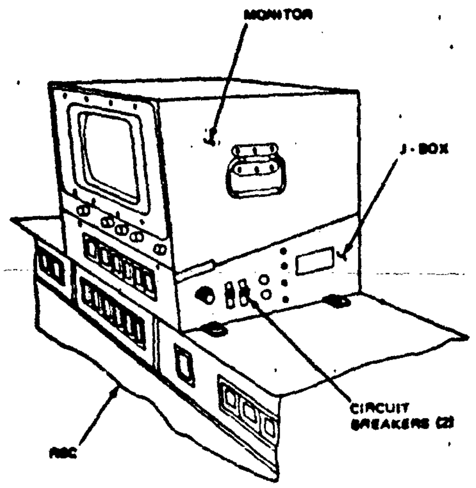
Implementation and Support

To facilitate EPICS' implementation, both the FPJPAs and PPJPAs were integrated into the Navy's 3M system with the assistance of NSWSES, Port Hueneme. This ensured that the JPAs would be listed on the maintenance index pages (MIPs), formally accounted for by the ship, updated periodically to reflect equipment/procedural changes, and provide a means by which the ship could request additional copies.

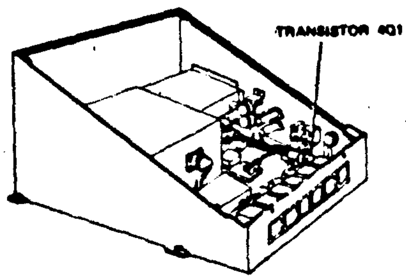
Test and Evaluation

JPAs are an integral component of the EPICS IPSA and the work cited above substantially advanced performance aiding as a personnel system technology. A number of variables were included in the T&E plan to address JPA effectiveness, including accuracy, user acceptance, job relevance, degree of use, and so forth.

This JPA contains procedures for removing and replacing a component that is located in the Junction Box (J-Box) located below the Television Monitor.



6. Look down in J-Box and locate transistor 4Q1.



4Q1 is a series pass power transistor used to control the brightness of the indicator lamps. Potentiometer 4R1 establishes a bias point to A1. Amplifier A1 regulates and maintains the voltage on the base of Q1 as determined by the setting of 4R1. Q1 turns on harder as the voltage on its base rises and thus applies more voltage to the lamps making them brighter. As the signal on the base of Q1 decreases, it turns down the voltage available to the lamps making them dimmer. As the lamps are set dimmer, Q1 must dissipate more power since it is acting as a series power resistor. In order to dissipate high amount of power, Q1 is mounted to a heat sink.

REF: OP 4053, Figure 3-80

5 of 7 12 EAKZ

11. Set CONTROL POWER circuit breaker to OFF; attach safety tag. This circuit breaker controls ship's service type 1 115V 60HZ 3PH power to Control Monitor.

12. At Static Frequency Converter (SFC), release and open access door; lock in open position.

13. Set CB1 to OFF; attach safety tag. Circuit breaker protects the 440V 3PH 60HZ power to filter rectifier (15/16 A4).

Figure 7. Examples of enrichment (hatched areas).

A and B: Overt enrichment information that is boxed off from the procedural information for a specific task.

C: Covert enrichment information that is embedded into the procedural information for specific task steps.

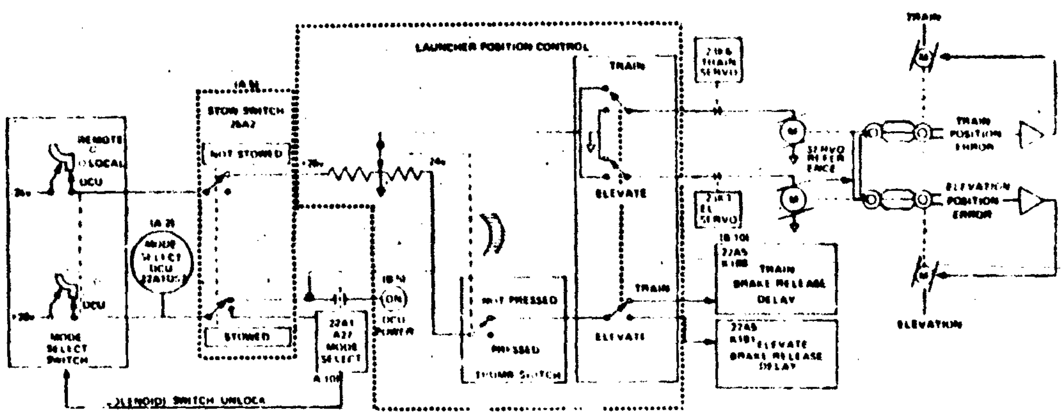
BZD

IF B REGISTER = 0, SET THE LSB OF D REGISTER AND LEFT SHIFT THE D REGISTER 1 PLACE, OR IF B REGISTER ≠ 0, CLEAR THE LSB OF D REGISTER AND LEFT SHIFT THE D REGISTER 1 PLACE.

STATE	SIGNAL NAME: CROM 12	CROM 13	CROM 14	CROM 15	SET D LSB, IF B CLEARED	SHIFT D STROBE	REGISTER B ZERO	ACTION/COMMENT
PAGE NUMBER	6-550	6-550	6-550	6-550	6-553	6-555	6-560	
CARD AND PIN NUMBER	A17-67	A17-65	A17-27	A45-3	A35-47	A35-13	A20-23	
CLOCK 1	0	1	1	0				SET D REGISTER LSB, IF B REGISTER = 0
					1			ENABLE SHIFTING D REGISTER
					1	1		SHIFT D REGISTER, LEFT 1 PLACE
CLOCK 3						1	1	1 TO D REGISTER LSB
							0	0 TO D REGISTER LSB
CLOCK 5-11								NO OPERATION

Figure 8. Example of a state table.

DCU OPERATION [AID 4006, VOL 2, PART 2 FIGURE 5 109]



DCU OPERATION

SYMPTOM	PROCEDURES
LAUNCHER DOES NOT MOVE IN DCU MODE	LAUNCHER MOVE IN LOCAL MODE? YES → FAULTY DCU SWITCH NO → TROUBLESHOOT POSITIONING CIRCUITS COMMON TO DCU AND LOCAL MODES SEE ELEVATION AND TRAIN SERVO POWER CIRCUITS
LAUNCHER MOVES IN WRONG DIRECTION	CHECK DCU SYNCHRO FOR POLARITY REVERSAL REALIGN DCU SYNCHROS
LAUNCHER OSCILLATES IN DCU MODE	TROUBLESHOOT POSITIONING CIRCUITS COMMON TO DCU AND LOCAL MODES SEE ELEVATION AND TRAIN SERVO POWER CIRCUITS

Figure 9. Example of an enriched hybrid JPA for the NSSMS launcher.

JBNZ

JUMP IF CONTENTS OF REGISTER B IS NOT ZERO. CROM BITS 0-10 IS THE JUMP ADDRESS

STATE	(1) CROM 12 (A17-67, 6-550)	(2) CROM 13 (A17-55, 6-550)	(3) CROM 14 (A17-27, 6-550)	(4) CROM 15 (A45-3, 6-550)	(5) ENB CONDITIONAL JUMP (A16-26, 6-551)	(6) INSTRUCTION CONTAINS ADDRESS (A19-7, 6-551)	(7) DEJUMP - (A36-27, 6-551)	(8) JUMP CLOCK (A81-3, 6-551)	(9) REGISTER B ZERO (A33-9, 6-560)	(10) JUMP (A16-13, 6-551)	(11) DEJUMPD - (A11-13, 6-551)	(12) JUMP ENABLED (A14-37, 6-546)	(13) ENABLED - (A16-51, 6-546)				ACTION/COMMENT
CLOCK 1	1	1	1	0													JUMP IF THE B REGISTER IS NOT EQUAL TO ZERO
					0	0											PREVENTS DECODING CROM BITS 0-10 AS AN INSTRUCTION
CLOCK 6																	LOAD CROM BITS 0-10 (JUMP ADDRESS) INTO THE JUMP ADDRESS STORAGE REGISTER (A46, U1,2,3/6-546)
CLOCK 7							0	0									IF A DEJUMP INSTRUCTION WAS PERFORMED PRIOR TO THIS INSTRUCTION, IT WILL HAVE CLEARED THE JUMP ENABLE F/F (A36, 6-551) DISABLING THIS JUMP INSTRUCTION - "PROCEED TO CLOCK 9"
							1	1	0	0							B REGISTER EQUALS ZERO; NO JUMP. CLEAR JUMP F/F (A14, 6-546)
									1	1							B REGISTER DOES NOT EQUAL ZERO; JUMP. SET JUMP F/F * (A14, 6-546)
CLOCK 9					0					1							CLEAR JUMP ENABLE F/F (A36, 6-551)
CLOCK 11											0	1					NO JUMP - PERFORM NORMAL ADDRESSING OF CROM
											1	0					PERFORM JUMP - JUMP ADDRESS STORAGE REGISTER TO CROM ADDRESS COUNTER (A64, U1,2,3/6-546)

* THE JUMP F/F (A14, 6-546), WILL BE CLEARED THE NEXT INSTRUCTION CYCLE AT CLOCK 7, IF THE NEXT INSTRUCTION IS NOT A JUMP. THIS IS DONE BY GENERATING THE JUMP CLOCK SIGNAL (A81-3, 6-551).

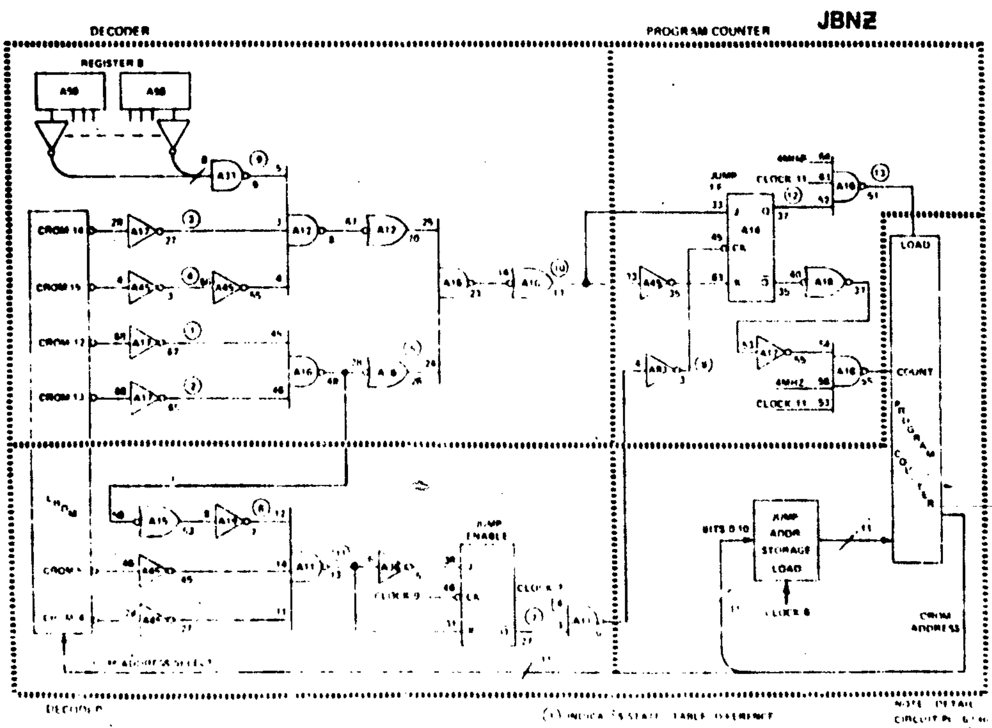


Figure 10. Example of an enriched hybrid JPA for the NSSMS missile control unit.

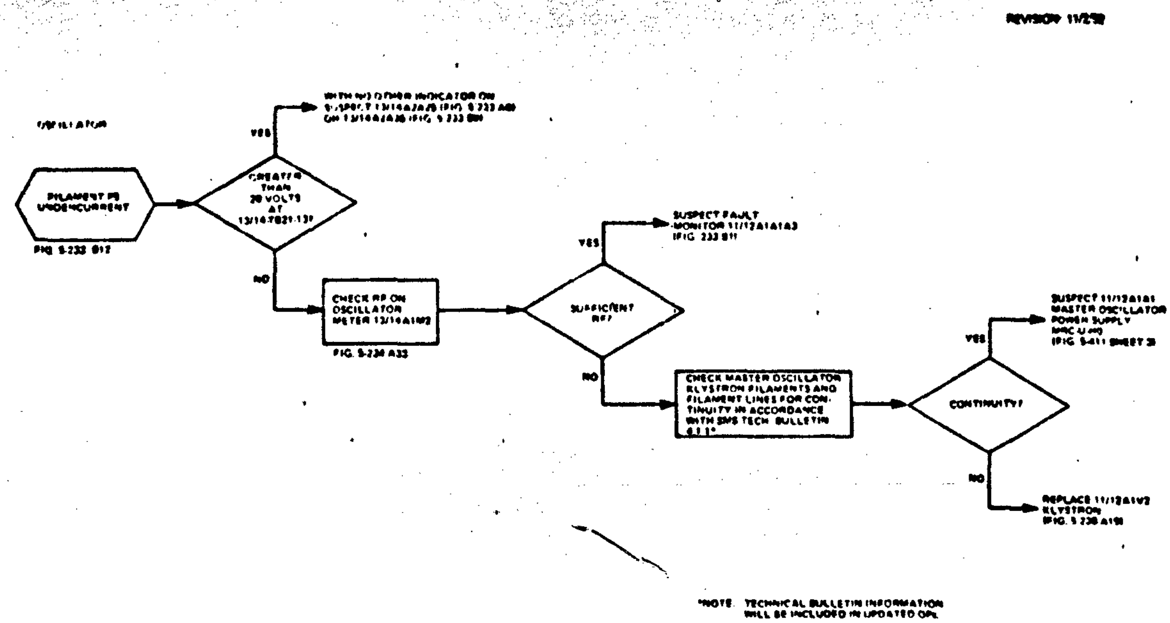


Figure 11. Example of a decision tree JPA for the NSSMS transmitter.

EPICS Progress Events/Processes

The EPICS program in T&E includes 15 events/processes, keyed to Figure 2, which are described below.

1. Recruitment. The recruiting inducements of the EPICS program have not been thoroughly analyzed since T&E subjects were already in the Navy and undergoing recruit training. However, a number of features that were designed into EPICS should translate into useful recruiting inducements and serve to individualize the career system, thus making it more adaptable to the particular skills, attitudes, and aspirations of a particular enlistee at a certain point in time.

2. Recruit Training. EPICS recruits receive the traditional basic training directed toward helping them transit from civilian to military life and providing them with the knowledge and attitudinal set necessary to becoming an effective member of the Navy. Currently, no specific intervention during recruit training is included within the EPICS model. However, for the T&E, cadres of EPICS recruits (8 to 10 men) attended a debriefing session just before they graduated from recruit training. During these sessions, which were headed by the EPICS project officer or a senior chief petty officer (CPO), a follow-up briefing on the EPICS program was provided and questions were fielded concerning travel, reporting aboard ship, and initial experiences to be expected on board ship. The "realistic job preview" approach was employed during these sessions in an attempt to reduce "reality shock" associated with adaptation to shipboard life. Subjects were provided with personal copies of the EPICS Sailors' Handbook at the session's close. Upon completion of recruit training, EPICS personnel are authorized to take 2 weeks leave before reporting to their duty station afloat.

3. At-Sea Orientation (ASO). After EPICS personnel return from leave and report to their afloat duty station, they begin a three-segment at-sea orientation (ASO) program designed to provide for assimilation and adaptation to shipboard life and for direct involvement in the ship's work. These segments are described below.

a. Ship Indoctrination (SI). During SI, recruits are introduced to shipboard routines, rules and regulations, and code of conduct. The five SI instructional modules were produced such that they could be used by all seamen recruits, regardless of rating, Major content areas are listed in Table 2 (p. 12). The primary objective of SI is to prepare recruits for transition to shipboard life with a minimum of stress, confusion, and personal difficulty. Emphasis is given to accelerating the recruit toward becoming a member of the group. Also, SI provides the standard general military courses that all recruits are required to complete. The SI program is flexible and designed to be coordinated with day-to-day shipboard workload. Recruits are required to complete all SI modules before entering the next ASO segment--job indoctrination (JI).

b. Job Indoctrination (JI). After EPICS personnel complete SI, they begin work within their assigned divisions. Also, they take a course of four JI modules, which provide an introduction to general safety procedures, general and special tasks, shipboard maintenance, and to NSSMS (Table 2). The JI segment was designed to help them adapt to the day-to-day routine of watchstanding and division work. Although they do perform compartment cleaning duties, they spend about half of their time obtaining real work experiences in shipboard operation and maintenance in their area of assignment. JI is intended to provide for direct involvement, group identification, and a sense of early accomplishment, thus aiding shipboard assimilation and enhancing satisfaction and morale. During this segment, personnel begin orientation training in the use of JPAs.

Those individuals who have been approved to enter EPICS career paths through lateral entry (usually from the general work force) enter during the JI segment. These individuals may or may not have had previous experience in the work center, but they must enter at JI to ensure that they meet all EPICS requirements. Upon completion of JI, EPICS personnel are usually promoted to seaman apprentice (E-2).

c. Mess Cooking. During ASO, mess cooking is treated as a normal, routine segment--a natural part of "paying one's dues" to become a sailor so that its undesirable nature (in some opinions) is not reinforced. Actually, one or two individuals became interested in mess management as a career during this time frame, which is consistent with the aims of career definition during ASO. For those who did perceive mess cooking negatively, the fact that they were well established in a working group and knew that they would return to that working group following their tour served to reduce their frustration. A course of monitored self-study is provided for off-duty hours to try to maintain their interest in the program materials and contact with their work group. Mess-cooking tours are noted in an individual's records to indicate that the requirement was fulfilled. Depending upon personnel availability and scheduling, mess cooking could occur during ASO or ATD (see 4 below).

4. Apprentice Technician Duty (ATD).

a. Job-based Experience. Following their mess-cooking tours, individuals rejoin their assigned division and commence ATD, which provides them with additional learning experiences and the opportunity to demonstrate their ability and interest in attending ETT. Although they are expected to perform facilities maintenance assigned to their division, they spend 4-6 hours per day in career-oriented work.

During ATD, EPICS personnel are provided with a preliminary set of FPJPAs to support their performance of job tasks and allow them to become contributing members of the work group. They also receive instruction in PMS forms preparation, reporting, parts ordering, parts drawing, and elementary logistics. They receive orientation in using JPAs during JI. Upon completing ATD, the EPICS technician will have spent about 1 year at sea. During this period, he likely will have been promoted to SN (E-3). Also, he will have qualified for the Sea Service Ribbon, so that when he transfers to shore for ETT, he will be identified as having sea experience.

ATD provides for early utilization of E-2/3 personnel through their direct contribution to maintenance of a complex shipboard system. They learn military factors and gain experience with general military duties, which is important for their later promotion to E-4. Also, their assimilation into ship's company is completed, which should give them a sense of self-accomplishment. In addition, supervisory personnel have had an opportunity to observe them in a wide variety of shipboard activities for use in deciding on their future investment potential.

b. Instructional Modules. In addition to obtaining job-based experience during ATD, EPICS technicians take a course of six self-paced instructional modules. These modules are provided to aid them in performing the job tasks contained in ATD. In this course, they are introduced to NSSMS operation and maintenance and to the operation of test equipment (see Table 2). Also, to prepare for ETT, they study a series of 14 ETT-P modules, which are actually the first 14 modules employed in shore-based ETT, and provide an introduction to basic electricity (see Table 2). They must be satisfactorily completed before an individual can qualify for ETT. Use of these modules on board ship helps extend the individual's knowledge base, provides a clue as to how he is likely to perform in ETT and facilitates early experience in the school house environment.

5. Screening/Appraisal for ETT. After the EPICS technicians complete the ATD and ETT-P modules and satisfy general military requirements, they are screened for candidacy for ETT, their first shore-based technical school. Shipboard supervisors select technicians for ETT on the basis of their adaptation, motivation, and demonstrated ability. Nonselection may have the effect of motivating an individual who has been a bit lax in completing prerequisites, such as ATD and ETT-P modules. These individuals may be held in the Track 1 path and given a stated amount of additional time to meet expectations.

Flexibility in decision making is stressed as this point. The ship is provided wide latitude in the manner in which such decisions are made. In the EPICS T&E, the R&D program paid for travel to ETT, which would not be the case in actual employment of EPICS. Guidance provided to the ship emphasized that the decision to send an individual to ETT is significant since it represents the first sizeable investment in the individual. Individuals sent to ETT who, for whatever reason, fall out of Tracks 1 and 2, represent wasted training resources. For the most part, the strategy employed to date has been to give the individual the benefit of any doubt and risk a possible Track 1 or 2 loss. This decision strategy might be altered somewhat when the ship is required to bear all TDY costs.

6. Equipment Technician Training (ETT). ETT is the first shore-based training episode of the EPICS program. It is an individualized, self-based course utilizing computer-managed instruction. The course includes 37 modules, divided into 5 major blocks of instruction: basic electricity (#1-14), basic troubleshooting (#15-19), basic electronics (#20-25), intermediate electronics (#30-34), and digital fundamentals (#40-44)

(see Table 3). As indicated previously, ETT candidates are encouraged to complete the basic electricity modules (1-14) during ATD before attending ETT. If so, they are tested on these modules at ETT. A fixed period of 14 weeks is allocated for ETT, after which time students are returned to their respective ships. Those students who have completed the basic electronics block (called the 20-series) but not blocks 3 and 4 (30-series and 40-series) may be returned to their ships and complete the final two blocks there under supervision of the ESA. In rare cases, students are allowed to complete the 20-series aboard ship. Upon completion of ETT, the EPICS technician typically is awarded designated striker status.

7. Appraisal of ETT Performance. Students can be returned to their ship at any time during ETT for disciplinary or academic failure reasons. The ship's CO would then decide where they should be assigned. Students who are academic failures could be reassigned to Tracks 2 or 3. Students who return to their ships before completing all ETT modules must complete all those remaining to continue in Track 1. Students who have good attitudes and are responsible members of the work center but who have insurmountable academic difficulties would likely be assigned to Track 2, where they could continue to pursue their Navy careers but would never be granted an NEC. It is stressed, however, that decisions regarding the EPICS technician's career track assignments are strictly the responsibility of his CO.

8. Equipment Technician Duty (ETD). After EPICS technicians have completed ETT and returned to their ship, they graduate to the use of PPJPAs and standard technical manuals. They are considered equipment technicians (skill level II) and are able to perform system tests, provide troubleshooting support, handle most of the routine preventive maintenance tasks of the work center, and perform remove/replace corrective maintenance tasks using PPJPAs. Not too long after assuming ETD duties, the individual is eligible for E-4.

During ETD, EPICS technicians take a course of eight modules (see Table 2). These modules, which support the development of skills necessary at the ETD level, deal with NSSMS test procedures and with developing operator skills, thus providing them with an expanded understanding of NSSMS. Also, EPICS equipment technicians study a course of 10 STT-P modules, which help to prepare them to progress to STT, the second shore-based training school. These modules serve to expand the individual's knowledge of the theory underlying NSSMS operation. Emphasis is given to the role of radar in combat direction systems and other electronic devices not previously covered (see Table 2).

9. Screening/Appraisal for STT. This is an important assessment point since STT is a significant shore-based training resource commitment. To be eligible, the candidate must (a) be a graduate of ETT, (b) have completed all ETD and STT-P modules, (c) have met all requirements (except time) for FTM3 (petty officer third class, pay grade E-4), (d) have 24 months of obligated service remaining following graduation from STT, and (e) be recommended by his CO. Further, only individuals who have demonstrated healthy attitudes toward the Navy, have a highly satisfactory work record, and are likely to make good leading petty officers are to be recommended for STT. Individuals who have difficulty completing all STT-P modules satisfactorily but who are motivated and are considered assets to the work center may be tutored at the ship's discretion. Those who have not completed the prerequisites by the time allowed or who are not recommended for some reason would remain in ETD as NEC-000s until they are discharged.

10. EPICS Technician's Career Decision. At this point, the EPICS technician must decide whether or not to extend his enlistment for 2 years (assuming he entered on a 4-

year obligation) or to reenlist. If he decides not to extend or reenlist, he will remain in ETD (skill level II) until he is discharged. He must extend or reenlist to be eligible for STT.

11. System Technician Training (STT). After EPICS technicians meet all prerequisites, they are sent TDY to STT, their second shore-based training episode. STT covers 18 weeks of instruction directed toward imparting the necessary technical knowledge to qualify the individual for full system operation and maintenance. The curriculum emphasizes casualty analysis, fault isolation techniques, and remove/replace procedures. The seven study units include (a) NSSMS theory, (b) computer complex, (c) operator consoles, (d) guided missile fire control system (GMFCS), (e) guided missile launching system (GMLS), (f) SEASPARROW missile, and (g) combat direction systems (see Table 4). EPICS personnel attending STT will have had the benefit of approximately 18-24 months of directly related shipboard experience on the system hardware. With this background, the EPICS technician as an STT student is uniquely prepared for advanced training.

With this event, the final investment is made in the individual's "head" for the first 6 years of the program. Although the individual will continue to use JPAs upon return to the ship, they will be of the "deductive" variety. The trade from JPAs (book) to knowledge/expertise (head) is essentially complete at this point of the EPICS program.

12. Appraisal of STT Performance. Students are assessed frequently during STT, using both paper-and-pencil quizzes and hands-on laboratory tests. As with ETT, students can be returned to their respective ships at any time during STT for disciplinary problems or academic failure. However, in view of the amount of experience individuals have prior to STT, losses during STT should be extremely small. Following successful completion of all STT requirements, the individual is awarded the NEC for the associated system area (FTM-1148 in the NSSMS instance). Shortly after returning to his ship, he would be eligible for FTM2 (petty officer, second class, E-5 pay grade).

For those who did not complete all STT course objectives during the 18 weeks allowed, a decision is made as to remediation strategy and the individual is returned to his ship to continue working and be tutored. Six months after the individual returns to his ship, his CO decides whether or not to award the NEC. Those who successfully complete the remediation period, pass the appropriate tests, and are recommended by their CO are advanced to system technician duty (STD) and continue in Track 1. Those who are not successful are evaluated and either continued at the ETD level in the work center as NEC-0000s or assigned elsewhere. Academic failures would likely be reassigned to Track 2 and continue to perform non-NEC duties in the work center. At this stage of the program, reassignments to Tracks 3, 4, and 5 represent loss of resource investment and must be very small in numbers if the EPICS deferred training concept is to be cost effective. Of course, individuals assigned to Track 2 cannot be granted an NEC unless they are returned to STT at some future date and complete the course successfully. As with all other career assessment points in EPICS, final judgment as to individual assessment and track reassignment lies with the ship's CO.

13. System Technician Duty (STD). After an EPICS technician completes STT, he is awarded an NEC and returns to his ship (or possibly to another ship) to complete his first 6-year obligation. As a "system technician" at skill level III, he is qualified to supervise preventive maintenance and most corrective maintenance and would perform complex troubleshooting and repair tasks for his division. He will fill a senior technician's billet and will be responsible for monitoring the training of EPICS technicians at ATD and ETD levels and performing other leadership functions. During this period, EPICS personnel who

want to qualify for the enlisted surface warfare specialist (ESWS) insignia have satisfied the time requirements and have had the opportunity to meet the other requirements. The ESWS insignia identifies surface ship personnel who have acquired the professional skills, knowledges and experience needed to attain this unique qualification on surface ships.

During STD, EPICS personnel have the opportunity to study a set of five instructional modules to expand their knowledge concerning peripheral equipment or functions that interrelate their particular system (NSSMS) with other systems (combat, propulsion, navigation, etc.) (Table 2). These modules are intended to expand the individual's capability at the STD level and to facilitate his career progression to the next level. For the NSSMS career path, this would lead to designation as an improved point defense system technician (IPDST) and eventually to a combat weapon system technician (CWST). (See appendix for a description of a 20-year career system).

14. Screening/Appraisal for Reenlistment. After at least 24 months as a systems technician at skill level III (E-4/5), the individual will complete his 6-year obligation. (Those who may have reenlisted at Event 9 will continue with the program, which will involve assignment to shore duty.) Due to the multiple screening and assessment points in EPICS, it is likely that most individuals who reach this point will be recommended for reenlistment. Those who are not recommended will continue in ETD until discharge (Track 5). Those who have already reenlisted and those who reenlist at this event would continue their career, possibly leading to the E-8/E-9 pay grade (see appendix).

15. EPICS Technician Career Decision (Reenlistment). The example of a 20-year career program described in the appendix, leading to CWST at skill level V (E-8/9), illustrates the kind of program that can be offered to increase the incentives for reenlisting. Any cash awards available, of course, will increase this likelihood. One of the final criteria by which an EPICS-type program can be evaluated is the proportion of system technicians who were retained at the 6-year career point. This would be a function of a number of factors, of course, but it is hypothesized that the availability of a 20-year career program (at least one longer than is currently available) should significantly influence the retention of senior technicians.

Career System Development

Typically, career plans for enlisted personnel are not based on progressive skill/knowledge requirements of a particular ship system area (e.g., combat system, machinery system, ship control system, etc.). Instead, they are based on occupational specialities (ratings) independent of shipboard system hierarchies, which must be served on an ever-broadening scale as the individual advances. As a result, career tracks sometime disappear while critical needs at the more senior levels in complex Navy systems afloat go essentially unfulfilled.

In the present instance, the needs of the combat weapon system on the DD 963 class ships are not reflected in the current Navy enlisted career structure for the NSSMS and the other subsystems composing the combat weapon system. As noted earlier, one of the project's objectives was to develop a career system integrated with shipboard skill requirements and system organization with intermediate career decision points for a 20-year enlistment.

Task analysis and job design studies provided the basis for EPICS career track development through the NSSMS system technician skill level (E-5/6). Beyond that point, career paths might include the MK-23 Target Acquisition System (TAS) or a broader

career path within the Improved Point Defense System (IPDSMS). Skill/knowledge requirements and associated career progression paths beyond the 6-year point for the NSSMS have yet to be defined. However, in an effort to provide preliminary planning information for a 20-year CWST career track, a career model was developed that integrates the major steps in the TAS and NSSMS career tracks into a CWST 20-year career system. This career system model is described in the appendix.

EPICS IMPLEMENTATION FOR TEST

It was acknowledged from the outset that one of the major challenges of the program was to accomplish fleet implementation and to exercise and support the system effectively over the prescribed test period so that the planned-for data could be collected. Consequently, a major project task was to design a change intervention strategy with promotional elements and supporting documentation.

Promotional Spinoffs

To have any hope of success, an intervention such as EPICS must offer one or more near-term payoffs, particularly where fleet units are concerned. Several such payoffs were purposely included in the EPICS development plan, including the following:

1. Validated and improved MRCs were produced and provided to the fleet through the Naval Ship Weapons Center Engineering Station as a spinoff from the behavioral task analysis effort for job design and JPA development.

2. Digital troubleshooting aids were developed 2 years before needed for EPICS to meet a current fleet need. The shipboard indoctrination (SI) module set, to be used to help EPICS personnel adapt to the shipboard environment, was designed to be generally applicable to all first-term personnel reporting aboard their first ship. SI modules were adopted by several ships and used as instructional aids for indoctrination purposes.

3. A JPA was designed to reduce the time and effort required to trace signals through a series of technical manuals.

4. A job indoctrination (JI) module dealing with the 3-M system was used by a number of ships for nonsupervisory 3-M qualification of ship's crew.

The point of planning for and developing such products is the recognition that interaction of an R&D agency with operational units must be on a quid-pro-quo basis. Any lesser arrangement is apt to result in frustration and possible failure of the R&D effort.

Briefings and Information Exchange

So that all participating agencies and ships were fully informed about EPICS and had a ready means for question resolution, considerable time was spent in describing the features of the program and acknowledging potential impacts, both positive and negative. In addition to administrative commands in Washington, D.C., orientation briefings were provided to fleet commanders, type commanders, group commanders, and personnel of individual ships in both Atlantic and Pacific Fleets.

Wherever possible, orientation briefings for individual ships included the CO, executive officer, division officer, leading petty officer, and work center supervisor. Every

attempt was made to address any reservations or objections voiced during these briefings and to suggest a strategy that would effectively reduce the risk or problem perceived. Fortunately, the EPICS concept of deferred training is not new. In fact, a considerable portion of the senior fleet community seems to subscribe to this concept, at least in principle.

To provide for on-going support during implementation and T&E, an EPICS fleet representative was assigned to the Atlantic (Norfolk) and Pacific (San Diego) fleets. These individuals, who were senior chief petty officers (FTCS), well versed in and an advocate of the EPICS program, were available on call to any fleet unit who felt it had a problem. In addition, they visited EPICS ships periodically to deliver materials, provide update briefings, answer questions and, on occasion, assist a ship with a particularly difficult maintenance problem. In no instance did they intervene between the ship and an EPICS technician. They became involved in problems only at the express request of the ship, and then served only as a facilitator in the decision process.

Since advocacy is extremely important to the success of operational test interventions, considerable emphasis was given to the importance of ensuring that persons assigned as ESAs were advocates of the program. In most instances, the ESA was the work center supervisor; however, in a number of instances an interested, capable second-class petty officer took the initiative and was assigned ESA duties. Whenever possible, the EPICS fleet representative would support the ESA and try to assist him with administrative tasks in integrating EPICS material and procedures with work center routine.

As might be anticipated, the ESA, particularly if he was the work center supervisor, played a critical role in shipboard implementation and conduct. This individual's impact on EPICS success, as well as the effectiveness of the total work group, is discussed in the companion report (Blanchard, Clelland, & Megrditchian, 1984).

EPICS Documentation

To assist in program implementation and to support the operation of EPICS during T&E, the following documents were produced and distributed to appropriate parties:

1. EPICS Orientation Booklet. Provided a fairly detailed synopsis of the program, stressed potential payoffs, and was used as a general program handout, particularly in ship and command briefings and for general information purposes.

2. EPICS Recruiting Pamphlet. Provided a brief overview of the salient points of the program and was used has a handout to EPICS candidates at RTC, San Diego.

3. EPICS Administration Guide. A detailed guide to the shipboard administration of the EPICS program, including a discussion of prerequisites, how to employ the job-aided technician, how to monitor an EPICS technician's progress in the shipboard instructional program, and reporting forms to be used by the ESA.

4. EPICS Sailors Handbook. A loose-leaf ring notebook provided to EPICS personnel just before they completed recruit training. Included an overview of the program, specific career points, prerequisites for career steps, and a log to enable the EPICS technician to track his own progress through the career steps.

5. EPICS "Log." A quarterly newsletter distributed widely to all EPICS personnel, ESAs, COs, and cooperating agencies within OP-01, NMPC, and NAVSEA. Used as a vehicle to (a) describe new developments, scheduling, and topics of interest, (b) acknowledge the progress of an outstanding individual, (c) provide special instructions, and (d) highlight critical program events.

STATUS AND PLANS

EPICS Field Test

Currently, EPICS is being subjected to a longitudinal field evaluation to assess the overall effectiveness and associated cost benefits of the various initiatives and approaches composing the program and to appraise the value of EPICS as an alternative to the current personnel system.

Each of the design objectives stated at the beginning of this report will be assessed for overall effectiveness and value as an alternative to the present system. Included are (1) cost-effectiveness of deferring training compared to existing front-end-loaded training, (2) value of providing initial skills training on board ship; (3) progress of non-school-eligible personnel through the various career steps, (4) usefulness of JPAs in terms of user acceptance and performance enhancement value, (5) usefulness of STEPS in building competence and facilitating individual career progression, and (6) impact of EPICS on attrition, career progression, and retention. Interim findings on the research questions stated above are available in the companion report (Blanchard, Clelland & Megrditchian, 1984).

Plans

The EPICS test and evaluation is longitudinal in nature. The EPICS technicians serving as subjects will be tracked throughout their enlistments and through all events and processes shown in Figure 2. It is anticipated that fleet data collection will be completed on all variables by November 1985. (All EPICS technicians will reach their EAOS by that date.) Computerized data bases have been established for all T&E variables to facilitate data compilation and comprehensive analysis. It is expected that all data analyses on personnel and system variables will be completed by March 1986.

Cost effectiveness analyses will be completed by March 1986, with all relative cost benefits defined for various scenarios of personnel resource use. Final reporting documents and end products will be forthcoming by September 1986.

EPICS major events and milestones are listed in Table 5.

Table 5

EPICS Major Events and Milestones

Event	Date
Project initiated (FY77)	Oct 1976
EPICS concept defined--test plan completed	Feb 1978
DCNO/MPT decision to proceed with fleet test	Oct 1979
CINCPACFLT endorsement	Mar 1980
CINCLANTFLT endorsement	May 1980
Shipboard manning with EPICS technicians initiated	Sep 1980
Equipment technician training (ETT) course initiated in San Diego (shore-based)	Aug 1981
EPICS shipboard manning completed--LANT/PAC Fleets (158 enrolees)	Nov 1981
System technician training (STT) course initiated at Mare Island (shore-based)	Oct 1982
NAVSEA requests EPICS be installed on improved point defense surface missile system (IPDSMS)	Nov 1982
Troubleshooting proficiency testing initiated in PACFLT	Mar 1983
First STT graduating class --NEC FT-1148 granted (11 students)	Mar 1983
ETT course completed for all qualifying EPICS personnel	Mar 1983
STT completed	Sep 1984
Complete fleet T&E	Sep 1985
Complete cost effectiveness analysis	Mar 1986
Final report and end products	Sep 1986

REFERENCES

Bauman, M. B., & DeBor, J. S. Job design final report for the enlisted personnel individualized career system (Final Rep. N00123-78-C-0086 (02CJ-20-49365)). Falls Church, VA: BioTechnology, Inc., July 1980.

Bauman, M. B., & DeBor, J. S. Task descriptive data final report and part 2 of the training analysis requirements report for the Navy's enlisted personnel individualized career system (Final Rep. N00123-78-C-0086 (P.O. 02DJ-20-43672). Falls Church, VA: BioTechnology, Inc., March 1980.

Bauman, M. B., & Price, H. E. Job design development guide for the enlisted personnel individualized career system (Final Report). San Diego: Navy Personnel Research and Development Center, April 1980.

Blanchard, R. E. An integrated approach to the design of personnel systems. Proceedings of the Human Factors Society--23rd Annual Meeting, 1979.

Blanchard, R. E., Clelland, I. J., & Megrditchian, A. M. Enlisted personnel individualized career system (EPICS) test and evaluation: Interim report (NPRDC Tech. Rep. 84-16). San Diego: Navy Personnel Research and Development Center, January 1984.

Blanchard, R. E., & Laabs, G. J. A personnel system concept with job performance aiding as a principal component: Preliminary model (NPRDC Tech. Note 78-6). San Diego: Navy Personnel Research and Development Center, February 1978.

Blanchard, R. E., & Smillie, R. J. Integrated personnel systems approach (IPSA): The enlisted personnel individualized career system (EPICS) model (NPRDC Tech. Note 80-14). San Diego: Navy Personnel Research and Development Center, May 1980.

Booher, H. R. (Ed.). Symposium Proceedings: Invitational conference on status of job performance aid (NPRDC Tech. Rep. 77-33). San Diego: Navy Personnel Research and Development Center, May 1977. (AD-A040 540)

Booher, H. R. Job performance aids: Research and technology state-of-the-art (NPRDC Tech. Rep. 78-26). San Diego: Navy Personnel Research and Development Center, July 1978. (AD-A057 562)

Booher, H. R. Job performance aid selection algorithm: Development and application (NPRDC Tech. Note 79-1). San Diego: Navy Personnel Research and Development Center, October 1978.

Defense Manpower Commission. Defense Manpower: Keystone of National Security, Report to the President and the Congress. Washington, DC: U.S. Government Printing Office, April 1976.

EPICS Project Development Office. EPICS Administration Guide. San Diego: Navy Personnel Research and Development Center, 1980.

EPICS Project Development Office. EPICS Sailor's Handbook. San Diego: Navy Personnel Research and Development Center, 1980.

Foley, John P., Jr. Job performance aids for UH-1H helicopter typically fully-proceduralized aids for non-troubleshooting tasks (AFHRL-TR-28). Wright-Patterson Air Force Base, Ohio: Air Force Human Resources Laboratory, June 1975.

Foley, J. P., Jr. Impact of advanced maintenance data and task oriented training technologies on maintenance, personnel, and training systems (AFHRL TR 78-25). Wright-Patterson Air Force Base, Ohio: Air Force Human Resources Laboratory, September 1978.

Klesch, J. J. Implementation of the JPA job oriented training approach to maintenance: Impact on personnel systems. In proceedings of the invitational conference on status of job performance aid technology (NPRDC Tech. Rep. 77-33). San Diego: Navy Personnel Research and Development Center, May 1977. (AD-040 540)

Megrditchian, A. M. Enlisted personnel individualized career system (EPICS) and convention personnel system (CPS): Preliminary comparison of training and ancillary costs (NPRDC Spec. Rep. 83-23). San Diego: Navy Personnel Research and Development Center, April 1983.

Osga, G. A., & Smillie, R. J. (Eds.). Proceedings of an invitational conference on job performance aids (NPRDC Spec. Rep. 83-39). San Diego: Navy Personnel Research and Development Center, June 1983. (AD-A130 698)

Post, T. J., & Smith, M. G. Hybrid job performance aid technology definition (NPRDC Tech. Rep. 79-25). San Diego: Navy Personnel Research and Development Center, July 1979. (AD-A072 445)

Price, H. E. A concept for a JPA-based job design process for an integrated personnel system (final report). San Diego: Navy Personnel Research and Development Center, July 1978.

Pulliam, R., Goett, J. M., & Smith, G. Enriched fully proceduralized job performance aids (Final Rep. N00123-78-C-0554(2)). Falls Church, VA: BioTechnology, Inc., July 1979.

Pulliam, R., & Goett, J. M. Guide for the development of enriched fully proceduralized job performance aids (Final Rep. N00123-78-C-0554(2)). Falls Church, VA: BioTechnology, Inc., June 1979.

Rowan, R. C. Improving DoD maintenance through better performance aids. Arlington, VA: Information Concepts, Inc., March 1973. (AD-758-713)

Serendipity, Inc. Project PIMO final report: PIMO final report summary (TR-69-155, Vol. I). Norton Air Force Base, CA: Space and Missile Systems Organization, Air Force Systems Command, May 1969.

Shriver, E. G., & Hart, F. L. Study and proposal for the improvement of military technical information transfer methods. Alexandria, VA: Kinton, Inc., December 1975. (AD-AO-23409)

Smillie, R. J., & Porta, M. M. Comparison of state tables and ordnance publications for troubleshooting digital equipment (NPRDC Tech. Rep. 82-7). San Diego: Navy Personnel Research and Development Center, October 1981. (AD-A107 945)

Smillie, R. J., Smith, M. G., Post, T. J., & Sanders, J. H. Enriched hybrid job performance aid development (NPRDC Tech. Rep.). San Diego: Navy Personnel Research and Development Center, in press.

Smith, M. G., Post, T. J., & DeBor, J. Identify and evaluate alternative technical data presentation schemes. San Diego: Navy Personnel Research and Development Center, December 1982.

Smith, M. G., Post, T. J., & Smillie, R. J. Field evaluation of enriched hybrid job performance aids (NPRDC Spec. Rep. 83-32). San Diego: Navy Personnel Research and Development Center, May 1983. (AD-A129 630)

APPENDIX

COMBAT WEAPON SYSTEM TECHNICIAN CAREER DEVELOPMENT PLAN

COMBAT WEAPON SYSTEM TECHNICIAN CAREER DEVELOPMENT PLAN

Problem

Typically, career plans for enlisted personnel are based on occupational specialities (ratings), independent of shipboard system hierarchies, rather than progressive skill/knowledge requirements of a particular ship system area (e.g., combat systems, machinery systems, ship control systems, etc.). As a result, career tracks sometimes disappear while critical needs at the more senior levels in complex Navy systems afloat go essentially unfulfilled.

For example, during development of the EPICS model, it was discovered that the needs of the combat weapon system on DD 963 class ships are not reflected in available Navy enlisted career structure for the NSSMS and other subsystems composing the combat weapon system. What is needed is a Navy enlisted career path structure that supports the various levels of expertise reflected by equipment, subsystem, system, and combat system.

Discussion

One of the EPICS project's major objectives is to develop a career system that provides explicit performance requirements, coordinated advancement paths, integrated ship and shore-based training, and career decision points for the NSSMS (the test vehicle for EPICS). Task analyses and job design studies were conducted to determine the various skill and knowledge requirements for the EPICS career track through the NSSMS System Technician skill level (E-5/6). This effort resulted in the development of an explicit career path for an NSSMS technician through his first enlistment. Currently, the NSSMS technician, after his first tour of shore duty, probably will be assigned to the MK-23 target acquisition system (TAS) "C" School before being reassigned to shipboard duty. At that time, he may be assigned to a TAS billet, an NSSMS billet, or to an improved point defense system technician (IPDST) billet. This IPDST duty assignment currently is only in the planning stages and the skill/knowledge requirements and the associated career progression paths have yet to be defined and documented. Also lacking is definition and documentation of skill/knowledge requirements for the career level after IPDST, the combat weapon system technician (CWST).

In an effort to alleviate the problems described above, NPRDC has developed a model that presents, pictorially, the projected major steps in the TAS and NSSMS tracks to CWST (see Figure A-1). As can be seen, training and experience for both tracks are, for all practical purposes, the same during the early stages. The bold dark lines indicate those episodes that have been completed during the EPICS project. The apprentice technician duty (ATD) and equipment technician duty (ETD) episodes have only one-half of the box blocked-in since the TAS operator self-teaching exportable packages (STEPs), JPAs, and ATD/ETD/STT-P STEPS still need to be completed if an EPICS-like program is to be provided for the TAS track.

Page 2 of Figure A-1 presents the CWST plan from approximately 16-18 months to the 10-year point. The NSSMS/TAS tracks separate to emphasize the need to learn and perform higher-level system-specific troubleshooting/maintenance tasks. NSSMS/TAS "cross-training" episodes occur at completion of the first shore duty period. This training episode is expected to be considerably shorter than the corresponding "C" school since the entry level of the personnel is significantly different. (It may, in fact, be possible to use modularized instructional materials for each system to accomplish this training without

need for a resident school.) At the very least, it should be possible to configure the "C" schools such that experienced personnel can enter at a point later in the course, thus maximizing this training episode. It should be understood that the terminal objectives of these "cross-training" episodes are the same as their corresponding system courses, the only difference being the reduced time and content that is possible due to prior shipboard experience of the personnel. Successful completion of cross-training in either track would qualify the individual to operate and maintain the NSSMS/TAS and therefore qualify for the NEC FT 1147. If the FT 1147 is defined to be the prerequisite for the IPDST duty position, then completion of the NSSMS or TAS cross-training episode qualifies the technician for the IPDST duty assignment.

Page 3 of Figure A-1 shows the CWST career plan from 10 to 20 years. The CWST duties have not yet been determined but it appears that this person will function as the assistant to the tactical action officer (TAO) during operational evolutions and as the department chief and assistant to the combat systems officer in daily routine operation and maintenance of the combat systems. The CWST will function as the technical expert in the department and will provide guidance during any systems interface issue (e.g., ship's alignment). In the context of this career plan, the CWST would be expected to continue as the senior technical expert rather than in such positions as senior enlisted administrator (SEA); master chief, petty officer of the command (MCPOC), and administrator.

Future Directions

Figure A-1 shows various options that are available and necessary to accomplish various facets of the tracks of the model.

1. Option A indicates the steps required to complete the NSSMS track to the FT 1147 NEC without JPAs, ATD, etc., in support of maintenance for the TAS. It does, however, provide for TAS operator training and the current NSSMS operator STEPS could be used by TAS personnel.

2. Option B illustrates the steps required to complete the TAS track to the FT 1147 NEC but does not provide for development of the TAS cross-training for the NSSMS technician.

3. Option C shows the steps required to complete both NSSMS and TAS tracks to the FT 1147 NEC. This could be accomplished utilizing the current TAS pipeline and modifying and adding to current NSSMS STEPS instructional modules to complete the TAS track. The TAS track would be non-EPICS since JPAs, ATD, ETD, and STEPS would not be developed for TAS. The NSSMS track would require only the development of cross-training on TAS.

4. Option D indicates the steps required to complete the CWST 20-year career plan, assuming that at least one of the FT 1147 tracks has been accomplished.

It should be noted that steps 1, 2, and 3 of Options A, B, and C are the same and that Option A provides the quickest, most efficient path to early NSSMS/TAS operator training and development of a career track to the FT 1147 NEC. Completion of A and B provides for an integrated NSSMS/TAS program that will provide FT 1147s from either the NSSMS or TAS tracks. Option C provides the quickest reaction to current fleet requirements in that early operator cross-training and a path to the FT 1147 is available for both NSSMS and TAS technicians.

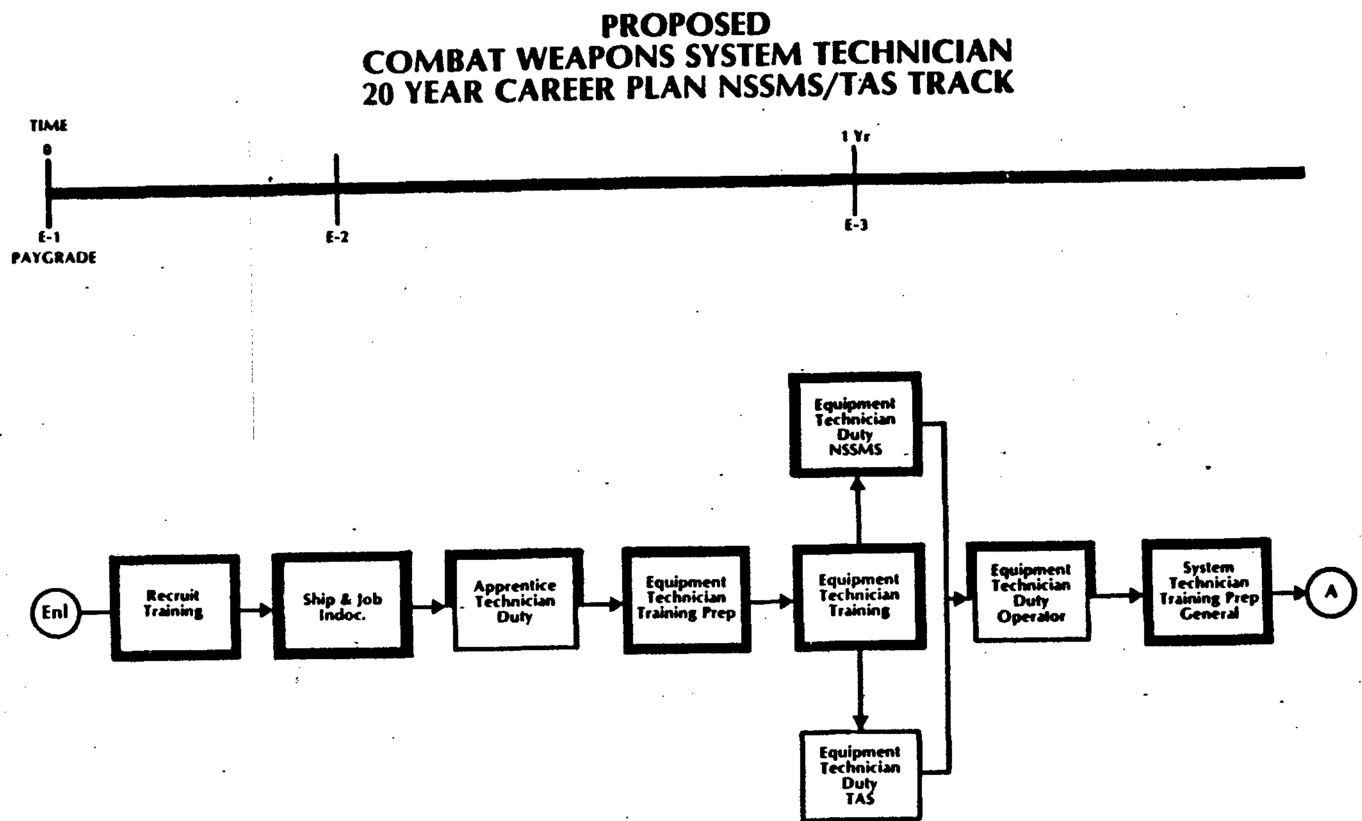


Figure 1-A. Proposed Combat Weapons System Technician 20 year career plan for NSSMS/TAS tracks.

PROPOSED
COMBAT WEAPONS SYSTEM TECHNICIAN
20 YEAR CAREER PLAN NSSMS/TAS TRACK
(continued)

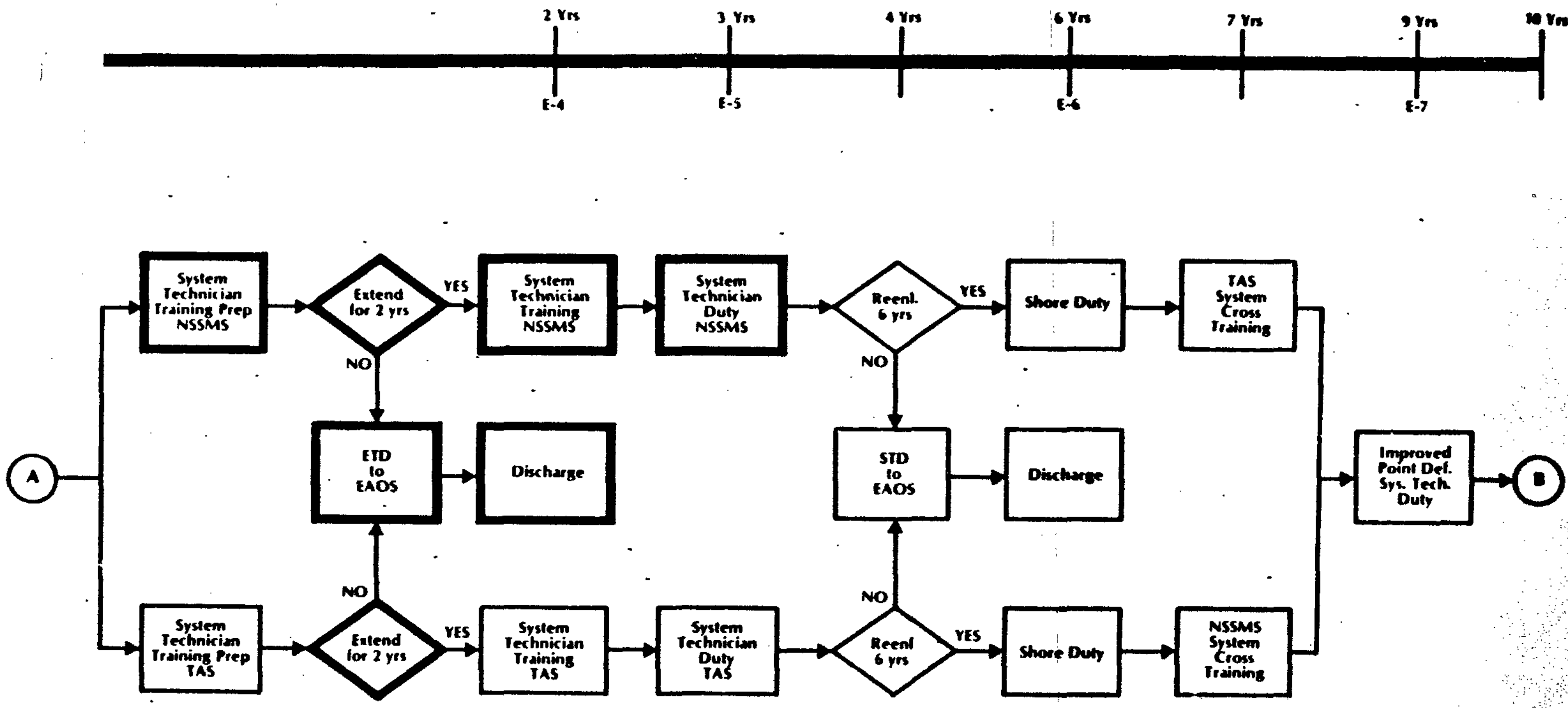


Figure A-1. (Continued).

PROPOSED
COMBAT WEAPONS SYSTEM TECHNICIAN
20 YEAR CAREER PLAN NSSMS/TAS TRACK
(continued)

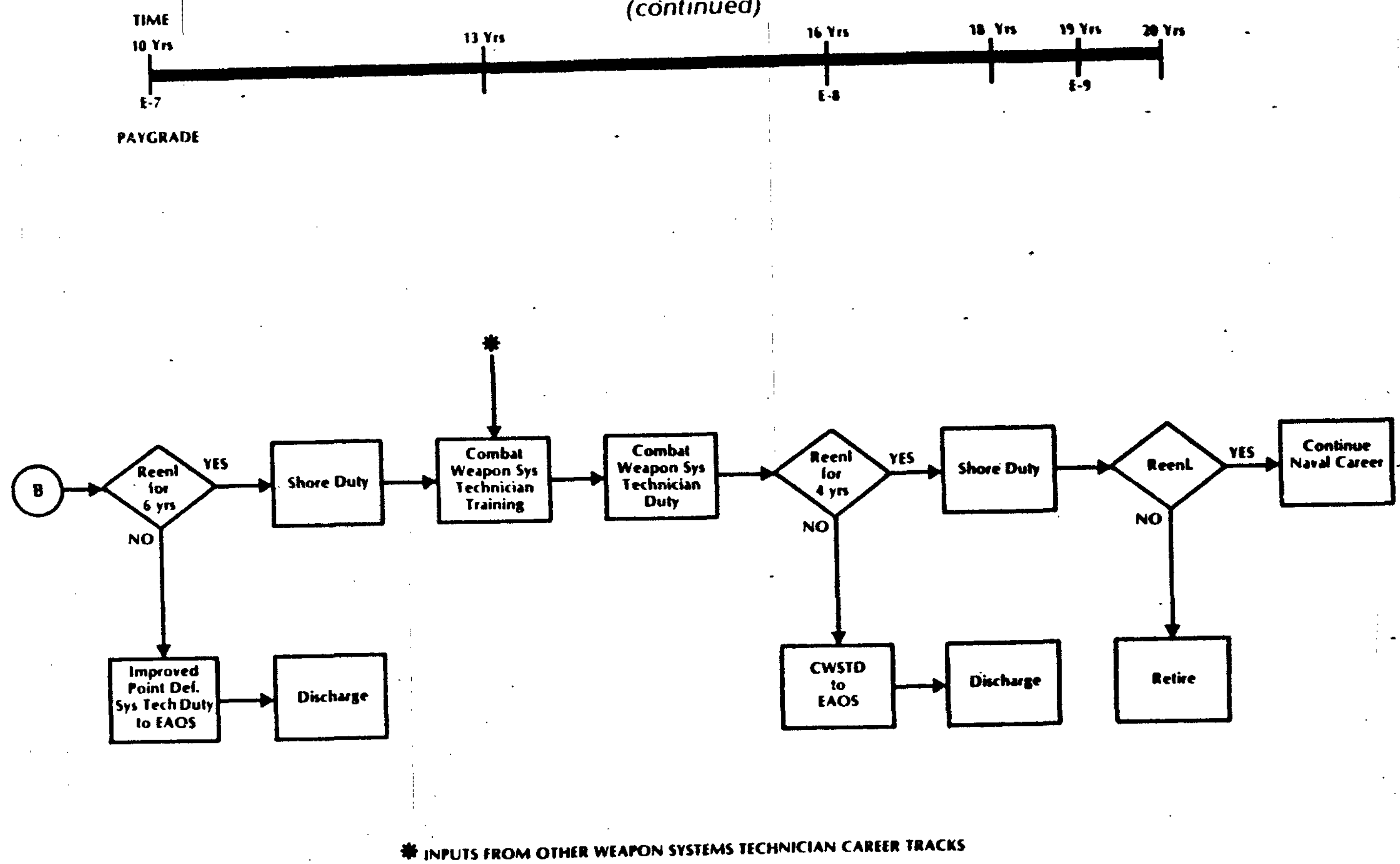


Figure A-1. (Continued).

DISTRIBUTION LIST

Chief of Naval Operations (OP-01B7) (2), (OP-135C4), (OP-140F2), (OP-987H)
Chief of Naval Material (NMAT 0722)
Chief of Naval Research (Code 270), (Code 440) (3), (Code 442), (Code 442PT)
Chief of Naval Education and Training (00A), (N-21)
Chief of Naval Technical Training (00), (016), (N-6)
Commandant of the Marine Corps (MPI-20)
Commander Naval Military Personnel Command (NMPC 013C)
Commander Navy Recruiting Command (Code 20)
Commanding Officer, Naval Aerospace Medical Institute (Library Code 12) (2)
Commanding Officer, Naval Technical Training Center, Corry Station (Code 101B)
Commanding Officer, Naval Training Equipment Center (Technical Library) (5), (Code N-1)
Director, Office of Naval Research Branch Office, Chicago (Coordinator for Psychological Sciences)
Commander, Army Research Institute for the Behavioral and Social Sciences, Alexandria (PERI-ASL), (PERI-ZT), (PERI-SZ)
Commander, Air Force Human Resources Laboratory, Brooks Air Force Base (Manpower and Personnel Division), (Scientific and Technical Information Office)
Commander, Air Force Human Resources Laboratory, Williams Air Force Base (AFHRL/OT)
Commander, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base (AFHRL/LR)
Commanding Officer, U.S. Coast Guard Research and Development Center, Avery Point
Institute for Defense Analyses, Science and Technology Division
Defense Technical Information Center (DDA) (12)